HANDBOOK

OF

FIRE CONTROL EQUIPMENT

U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

THE
FIRE-CONTROL EQUIPMENT
Handbook

1946

Compiled and currently maintained by the Forest Service through its committee on fire-control equipment and development and standardization, with material assistance afforded by other Federal, State, and private agencies, individuals, and equipment manufacturers and dealers.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

F
CONTROL
Equipment Development
Handbook

Washington, D. C.,
November 1, 1946

REGIONAL FORESTERS AND DIRECTORS:

This Handbook of Fire Control Equipment and the associated Master Specification File should be of direct use to Fire Control technicians and managers, both within and outside the Forest Service.

It is highly desirable that the Handbook and Master Specification File be kept up to date by systematic revisions. Such current information, clearly presented, should give constant encouragement to further improvements and invention in the Fire Control equipment field. We welcome additional Handbook material from all interested agencies.

The Foreword specifies the functions of the National Fire Equipment Committee, the policy governing revision of the Handbook, the publication of Fire Control Notes, and standards which apply to Forest Service purchase of equipment. The policies and procedures set forth in the Foreword are hereby approved, effective immediately.

Lyle F. Watts

LYLE F. WATTS
Chief, Forest Service

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FOREWORD

The objectives of the Fire Control Equipment Project, of which this handbook is a part, are: To provide the U. S. Forest Service and other cooperating or participating agencies a source of information on forest fire control equipment; to stimulate and guide equipment development; to promote better equipment utilization; to aid in the selection and purchase of items of equipment best suited to local conditions; to standardize equipment on the national forests to the extent practicable; and to provide a master specification file.

The master specification file gives detailed specifications covering many items of fire control equipment which are described and illustrated in the handbook. The availability of these specifications is of major importance. It will facilitate standardization, where that is desirable, reduce the difficulties encountered in purchasing fire control equipment, and promote better understanding among manufacturers, dealers, and purchasing agents, all of which will result in material saving of time and expense.

While mandatory specifications for many items of fire control equipment have been adopted, this should not lessen further experimentation and new development. It is hoped that the handbook and master specification file will stimulate a more orderly and rapid development program, and that the dissemination of information thus acquired will benefit all fire control agencies.

Federal, State, and private forest fire protection agencies, forest schools, equipment manufacturers and dealers, or anyone else cooperating in any manner in forestry activities and having a real need for this book may secure a copy by request and explanation of need to the Chief, U. S. Forest Service, Washington, D.C. The book will be delivered unbound, but punched to fit standard commercial binders.

The standard binder (such as produced by Master Craft and by Remington-Rand) which will be used by the Forest Service can be purchased locally.

THE MASTER SPECIFICATION FILE

A master file, containing detailed specifications for all handbook items for which numbers appear in the "Specification Number" column of the index, is maintained by the Forest Service. Specifications from this file are available to all Federal, State and private forest protection agencies, and to anyone else having legitimate use for them. No charge will be made for specifications.

Federal Government agencies should obtain needed specifications from the Procurement and Supply Section, Forest Service, Washington, D. C., except that their branch offices in the far West may obtain them from the regional foresters. State and private agencies should obtain needed specifications from local regional foresters. In all cases, requests should give both the name of the item and the specification number, as listed in the index.

Each regional forester will need to stock a supply of specifications, but the supply should not be large as it can be quickly replenished. Holding stocks to the minimum needed will prevent undue losses when revisions are made.

Central stocks of specifications will be maintained by the Procurement and Supply Section, Forest Service, Washington, D. C., and the Forest Service Print Shop, Government Island, Alameda, California. Regions 7, 8 and 9 should requisition from Washington; other regions from Government Island, Alameda, California.

Individual regions are not authorized to reproduce master-file specifications, as obviously it cannot be done as economically in the regions as it can at the central point where plates good for many prints are maintained.

AMENDMENTS AND ADDITIONS

Amendments and additions to the handbook ordinarily will not be issued more often than once a year or less often than once in 2 years. Amendments and additions to the master file will be made at like intervals, except where it is necessary to amend specifications between regular amendment periods. If agencies, organizations, or individuals who have secured handbooks from the Forest Service desire future amendments and will so notify the Chief, Division of Fire Control, Forest Service, Washington, D. C., they will be furnished them when printed.

Agencies other than the Forest Service are requested to submit additional material for the handbook or specifications for the master file, together with any recommendations for amendments either to the Supply Officer, Procurement and Supply Section, Forest Service, Washington, D. C., or to the local regional forester. Contributions may be submitted at any time for consideration by the equipment committee.

In order that data may be properly submitted, the following information is offered.

Handbook Data.—Only data pertaining to such items of equipment or processes as have been tested, tried, and proven to be beyond the experimental development stage will be considered for inclusion in the handbook.

Data submitted for inclusion in the handbook should contain a brief but comprehensive description of the item or process, stating its range of usefulness and limitations. It should set forth for each item:

1. What it is.
2. What it will do.
3. Where it will work.
4. Where it will not work.
5. Its dimensions, weights, etc.
6. Approximate cost.

For home-made items, the material used and method of construction should be clearly outlined. Photographs should be submitted for all except the most common equipment items. Six prints of each photograph, or *preferably one print and the negative,* should be submitted. Photographs with unnecessary or distracting backgrounds *cannot be used.*

Specifications.—In preparing specifications for the master file, the outline and form of existing specifications should be followed. Any drawings should be prepared so that when reduced to letter size (8 by 10½ inches), with a one-inch margin at top and left side, they will be clear and legible. However, if drawings not in proper form for reduction are already available, they may be submitted and the committee will have them redrawn as necessary. Specifications submitted should be complete in every detail, except the specification number and date. Six copies of written material should be submitted. If drawings are originals, the committee will have the necessary number of copies made.

Revisions. — Recommendations for revision of handbook items or specifications should be accompanied by complete supporting data, setting forth clearly all circumstances surrounding the case.

All Forest Service data should be forwarded through the local regional office, where they will be given preliminary review by the regional committee member. Regional data may be submitted to the Procurement and Supply Section, Forest Service, Washington, D. C., currently, or annually by December 31. Data pertaining to individual equipment items should be on separate sheets to facilitate handling and filing.

Comments, criticisms, and suggestions for increasing the usefulness and efficiency of the fire control equipment handbook and master specification file are desirable and welcome.

NATIONAL FIRE CONTROL EQUIPMENT COMMITTEE

The National Fire Control Equipment Committee shall be comprised as follows:

Chairman: A member of the Washington Division of Fire Control.

Secretary: The chief of the Procurement and Supply Section of the Washington Office.

Regional members: One from each Forest Service region except Region 10, for which representation is optional with the regional forester.

Other members: One from each of the Washington Branches of State and Private Forestry and Research, and the Washington Division of Engineering.

Regional members will be designated by the regional forester. Each regional forester will be responsible for notifying the committee chairman who will be the regional committee member and of subsequent changes at the time they are made.

DUTIES AND RESPONSIBILITIES OF THE COMMITTEE CHAIRMAN

1. Responsible for administrative action to insure attainment of objectives established for the Fire Control Equipment Project.
2. Responsible for Service-wide coordination in development and use of fire control equipment and for maintenance of cooperative relations with all fire control agencies.
3. Serves as active chairman at all committee meetings.
4. Establishes the time and place for all committee meetings.
5. May request attendance of any forest officer or other specially qualified person at any committee meeting.
6. Represents the committee in seeking needed approval of and action on transactions of the committee.
7. Acts as a clearing house for progress reports, recommendations, and information on fire control equipment experimental, betterment, and development projects.

DUTIES AND RESPONSIBILITIES OF THE SECRETARY

Under direction of the chairman will be responsible for:

1. Maintaining the master specification file.
2. Rendering prompt service to Forest Service regions and all other fire control agencies desiring copies of specifications or information regarding them.
3. Reviewing all incoming material for completeness and conducting any necessary correspondence relative thereto with sending agencies or committee members.
4. Assembling, correlating, and otherwise preparing as completely as possible all material to be acted upon by the assembled committee.
5. Acting as clearing house and information bureau between regions, committee members, and other agencies.
6. Obtaining general use of the master specification file by Forest Service procurement officers.

DUTIES AND RESPONSIBILITIES OF EACH NATIONAL COMMITTEE MEMBER

1. Responsible for the preparation of amendment, addition, and revision contributions from his unit.
2. Responsible for checking and reporting upon equipment-betterment and development projects and assignments, including cooperative and private developments within his unit.
3. In cooperation with the appropriate division, to handle all correspondence relating to the subjects or projects involved on a region level.

4. With approval of his superior, to attend all committee meetings and to travel interregionally as directed by the chairman for the purpose of coordinating equipment development, demonstration, and use.

5. Will be duly authorized and fully prepared to speak for his region, branch, or division and to vote upon any subject. His vote will represent the choice of his unit.

6. To give assistance, as requested by the chairman or secretary, in reviewing data submitted by other departments or other agencies and in carrying on related correspondence.

7. To correspond with other committee members and other agencies in order to inform them of local developments and to keep posted on current progress and new developments elsewhere.

DUTIES AND RESPONSIBILITIES OF THE COMMITTEE

1. Regular, assembled committee meetings will be held annually or biennially, as may be necessary.

2. Seven committee members shall constitute a voting quorum. Voting by correspondence is permissible on subjects referred to the members by the chairman.

3. Committee will review all equipment specifications submitted, adopt specifications as standard for Service-wide use or for inclusion in the master file as nonstandard specifications, and amend the file and the handbook accordingly.

4. Committee will review all amendment data and additional general material submitted for the handbook, selecting therefrom and preparing in final form such data as are to be included.

5. Unless and until disapproved by the chief's office, decisions made and standards adopted by the required voting quorum of the committee will be binding upon all regions regardless of membership representation.

6. Committee will review and pass upon recommendations for equipment-development work and will recommend specific project assignments.

7. The committee must give careful consideration to all equipment-betterment recommendations submitted. The adoption of various items as standard does not obviate the need for betterment in many cases or the necessity for considering the possibilities in any case.

AGENCIES OTHER THAN THE FOREST SERVICE

1. As previously stated, other agencies are invited to submit handbook and master-file material for consideration by the committee.

2. Other agencies are encouraged to correspond freely with or contact committee members, the secretary, or the chairman regarding any phase of the work.

CRITERIA USED IN DESIGNATING SPECIFICATIONS AS MANDATORY FOR FOREST SERVICE USE

Specifications will be designated as mandatory when:

1. The Forest Service is a large purchaser of some piece of fire control equipment and a majority of regions believe that standardization will yield more in economy, quality, design, or relations with manufacturers than will be lost in other ways by such action; or when,

2. Conclusive evidence indicates that all purchasing should be done under one or more mandatory specifications to avoid serious complications in relationships with dealers and manufacturers or with federal or other agencies.

3. Before an item is designated as mandatory, the proposition will have been referred to the regions and their recommendations considered. Thereafter, the voting quorum stipulation shall prevail in designating specifications as mandatory for Forest Service use.

OBSERVANCE OF MANDATORY SPECIFICATIONS IN FOREST SERVICE PURCHASING

1. Where there are specifications designated as mandatory for the type of equipment needed for fire control work, their use by purchasing officers is required.

2. When a region feels that there is urgent need to change or waive some item in a specification but there is not time for reference to the entire committee, the Chief, Division of Fire Control, will act upon such a recommendation without reference to the committee. Copies of such requests and of the action thereon will be sent to the secretary of the committee.

3. When there is time to do so, any region desiring a change in a mandatory specification should present its request in a letter to the chairman with copies to all other members of the committee. After waiting a reasonable time for the comments by all members, the chairman will decide the question. Majority judgment will be followed when that can be ascertained, but ordinarily new angles raised by members will not be referred to the committee. Copies of the chairman's decisions will be given to the secretary.

4. Deviations from mandatory specifications for strictly experimental purposes may be made without any reference to the chairman or committee members.

5. It is recognized that deviations from mandatory specifications may be necessary in fire emergencies.

CENTRALIZED PURCHASES

Except in fire emergencies, Forest Service purchase of certain items of equipment will be restricted to specifically designated regions and the Washington Office. These are items which ordinarily should be purchased in this manner for several reasons: (1) To facilitate compliance with specifications, inspection, and test; (2) to interest larger and more responsible manufacturers and to obtain lower quotations; (3) to encourage and facilitate development by manufacturers; (4) to overcome provincialism and to promote wider interest; (5) because a region has dies, patterns, or other facilities which enable it to produce the article to advantage.

The agency responsible for supplying Service needs for certain items is indicated in the "Reference-Information column of the handbook index; e.g., WO-P, RI-P, etc.

EQUIPMENT–DEVELOPMENT WORK

Each region will be expected to carry on its proportionate share of equipment-development work, and to fulfill such direct assignments as may be made.

Other agencies are invited to cooperate by notifying the committee chairman, secretary, or local member of contemplated projects, and to submit progress and summary reports of work undertaken by them. Information concerning equipment-development projects undertaken or proposed by the Forest Service will be furnished upon request to the chairman, secretary, or to any committee member. Agencies desiring to carry on cooperative projects should contact local Forest Service officials or the local regional committee member.

FIRE CONTROL NOTES

The Forest Service publication Fire Control Notes is the official organ in which will be published currently any article submitted containing general progress reports, recommendations, or personal viewpoints concerning items or subjects which may eventually furnish handbook and master-file material, but which have not as yet reached a stage of development or acceptance warranting their use in that manner. Fire Control Notes should be considered an open forum, and handbook users are encouraged to make full use of it. Agencies other than the Forest Service are especially encouraged to submit their data and viewpoints for dissemination. Mail such data directly to: Division of Fire Control, Forest Service, Washington, D. C.

SECTION A

FIRE-DANGER MEASURING EQUIPMENT

The items listed on the following pages have been developed, or adapted, mostly for use in measuring fire danger. Many standard meteorological instruments which in many instances would serve the same purposes are also availabe, but have not been listed because they are adequately described in available catalogs or are too expensive for general fire control use. In general, only items that are useful in more than one region have been included.

For some items, notably anemometers and psychrometers, several makes or types have been widely used and are giving satisfactory service. In describing anemometers, no attempt has been made to discriminate between makes, but only to point out good or bad features of design. An attempt was made in describing psychrometers to point out the uses to which each type is especially adapted or not adapted.

The prices quoted are for single instruments at retail unless otherwise specified. Many items are obtainable for less when bought on contract or in quantity.

Fire-Danger Meters and Tables

Fire-danger meters and tables are used to integrate into convenient numerical indexes measurements of significant factors that determine whether fires will start, spread, and do damage. Most of the meters in use rate only the severity of burning conditions, called the burning index. One, in the Northern Rocky Mountain Region, includes risk and visibility factors to get a danger rating that is directly indicative of preparedness requirements. With other meters, risk and visibility factors are treated separately in determining preparedness action.

The significant factors integrated by the several meters differ, depending on the importance of the factors in the major fuel and cover types common to the regions involved. Some meters have been used successfully outside of the specific areas for which they were designated.

Information on fire-danger meters used in the various regions and sets of forms for recording danger data conveniently and efficiently can be obtained from the regional foresters.

Fire-Danger Boards

Fire-danger boards show at a glance the status of fire danger and its component factors. The Region 6 board (fig. A-1) has a strictly display function.

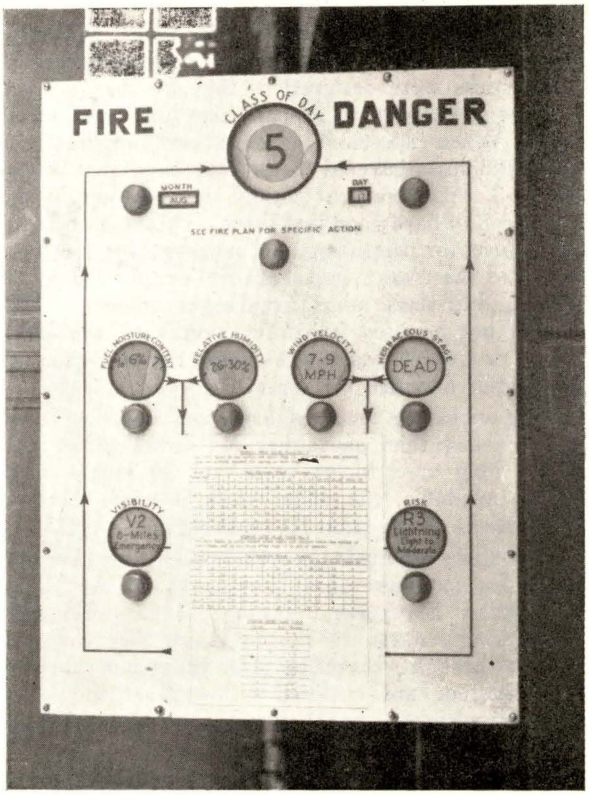


FIGURE A-1.—Region 6 fire-danger board.

Fuel-Moisture Indicator Sticks

Half-Inch Diameter Fuel - Moisture - Indicator Sticks.—The half-inch diameter fuel-moisture-indicator sticks shown in figure A-2 provide a standardized method for obtaining uniform estimates of the current moisture content of litter-type forest fuels. When exposed to the weather in or adjacent to forested areas, they gain or lose moisture in the same manner as the dead fuels in the vicinity. They are standard equipment at fire-danger stations in Regions 1 to 6 inclusive, and have useful applications elsewhere.

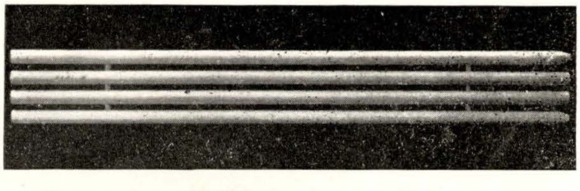


FIGURE A-2.—Half-inch diameter fuel-moisture-indicator sticks.

Each unit is composed of four dowels of clear ponderosa pine sapwood, ½ inch in diameter and about 20 inches long, mounted ½ inch apart on two 3/16-inch hardwood dowels, and weighs 100 grams when over-dry. Changes in the original weight and in hygroscopic characteristics after prolonged exposure make it advisable to replace the sticks each year. Price is approximately $1.30 per set.

Appalachian Type Fuel - Moisture - Indicator Sticks.—The Appalachian type fuel-moisture-indicator sticks were designed to indicate the moisture content of fuels in the Appalachian hardwood forest types. When exposed on wire brackets 8 inches above a natural litter-covered forest floor, as shown in figure A-3, they represent closely the moisture in the top layers of hardwood leaf litter. They are standard equipment for measuring fuel moisture for use with either of the two Appalachian fire-danger meters or the longleaf-slash pine fire-danger meter. They should not be used in conjunction with the Lake States or Central States fire-danger meters or any of the meters designed for use in the West.

The sticks are made of basswood venetian blind stock ⅛-inch thick and either 2⅜ inches wide by 18 inches long or 2 inches wide and 20 inches long. When available, the wider stock is used. Sets of three sticks weigh from 85 to 105 grams.

The sticks are made up, weathered, calibrated, and tested for accuracy and uniformity by the Appalachian Forest Experiment Station. The preliminary weathering reduces the rate at which they will lose weight through weathering after being put into use. A calibration card, enclosed with each set, shows the oven-dry weight of the sticks after various periods of use.

The sticks can be obtained without charge from the Appalachian Forest Experiment Station, Federal Building, Asheville, N. C.

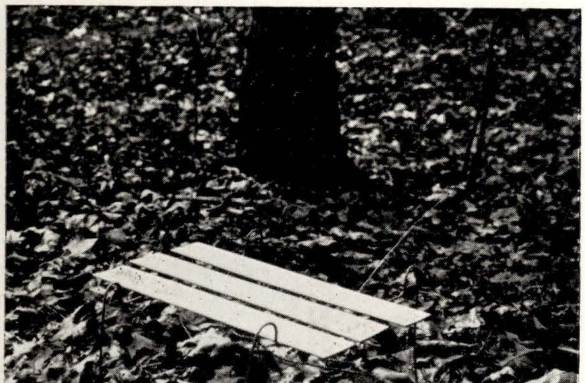


FIGURE A-3.—Appalachian type fuel-moisture-indicator sticks.

Fuel-Moisture Scale.—The fuel-moisture scale (fig. A-4) provides a ready means of measuring the moisture content of any fuel-moisture indicator sticks which weigh not less than 75 nor more than 115 grams when oven-dry. They indicate fuel moisture in percent of oven-dry weight with an accuracy of +0.25 percent from 0 to 20, and +0.5 percent from 21 to 50. The dial is graduated in whole numbers, but tenths can be estimated quite reliably up to 25 or 30 percent. A sliding weight on the indicator arm permits adjustment for sticks of different oven-dry weights and for changes in weight due to weathering. The over-all dimensions are 10 inches by 12 inches.

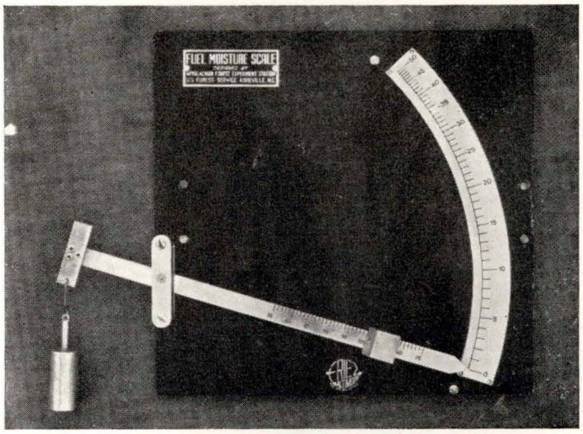


FIGURE A-4.—Fuel-moisture scale.

The back is aluminum, the balance arm pivot pin nickel silver, and all other parts solid brass. Each scale is equipped with a test weight, screws for mounting, and a packing box. Cost, about $13.50 to $17.50.

Where fuel-moisture-indicator sticks are calibrated to 100 grams oven-dry weight and adjustment for weathering is not made, as in western regions, the graduations and sliding weight on the indicator arm are not needed, and the sliding weight is a disadvantage, as it may become moved accidentally. The Forest Service specification provides for a plain indicator arm where it is desired. This will, of course, reduce the cost somewhat.

Triple-beam Laboratory Balance.—The triple-beam laboratory balance (fig. A-5) has been used extensively for weighing fuel-moisture-indicator sticks, especially in Region 1, where the sticks are calibrated to 100 grams oven-dry weight. Where this is not done, the balance is not as convenient as the scale shown in Figure A-4, as it shows the total weight of the sticks in grams and the moisture content in percent must be computed by the following equation or obtained from a table or chart based on this equation:

$$\text{Percent moisture} = \frac{(\text{Total Wt.} - \text{Oven-dry Wt.}) \times 100}{\text{Oven-dry Wt.}}$$

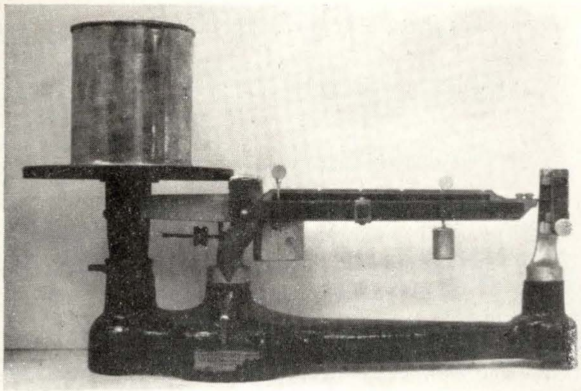


FIGURE A-5.—Triple-beam laboratory balance.

The balance is graduated in grams and tenths of grams from 0 to 610. The frame is cast-iron painted black, the beams of stainless metal, and the bearings are of the knife-edge type of hardened steel resting on agate. Balances having suspended weights on the 10- and 100-gram beams are generally more reliable than those having block-shaped weights riding on the beam, as there is less likelihood of error in setting the weights. Balances of this type cost about $12.

Measuring Wind Velocity

Anemometers.—There are at least five kinds of low-cost anemometers on the market suitable for measuring wind velocity for fire-danger measuring purposes, in addition to the more expensive standard meteorological instruments. One of these is illustrated in figure A-6. All are cup-type anemometers, some with three and others with four cups, 2 to 3 inches in diameter. Some have hemispherical and others conical cups; some beaded-rim cups, others unbeaded. All have stainless steel spindles. Some have ball bearings to carry the weight of the spindle and cup-wheel, others a hemispherical bearing resting on a hard, flat plate. One type has oilless bearings. All of them close an electrical circuit for the passage of each 1/60 mile of wind, so that the number of contact closures per minute represents miles per hour of wind velocity. The electrical circuits terminate in "pigtail" wires or convenient binding posts. All have rustproof, weather-tight housings.

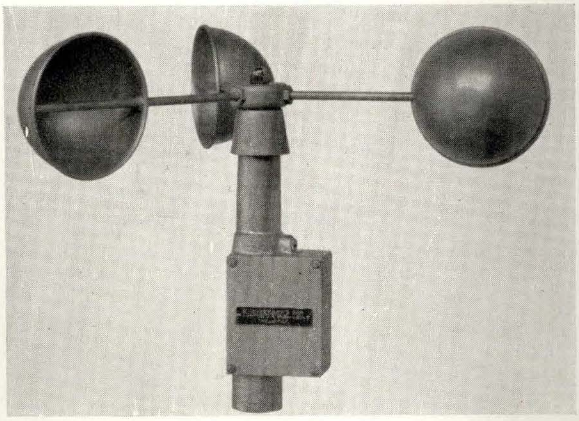


FIGURE A-6.—Three-cup anemometer used in measuring fire-danger.

All but one of the five kinds require correction tables to get true wind velocity. All are of approximately equal accuracy, about +1 mile per hour for winds of 3 miles per hour or more.

In anemometers, light metal cups are preferred to plastic cups, and the working parts should be readily accessible for adjustment and repair. Cost range from $7.50 to $18.

Anemometer Correction Tables.—Very few anemometers indicate a wide range of wind velocity with acceptable accuracy. Correction tables can be obtained from the manufacturers. The Appalachian Forest Experiment Station can supply sample tables for most types.

Measuring Wind Direction

Wind Vanes.—Several excellent low-cost wind vanes, suitable for measuring wind direction for use in fire control, are on the market. All have streamlined construction to reduce flutter, are well balanced, and turn on ball bearings. They are made of rust-proof materials and are equipped to mount with standard pipe fittings. Costs range from $3.50 without the N, E, S, W direction letters, and from $5 to $12.50 with the letters. The vane illustrated in figure A-7 is the R-6 type.

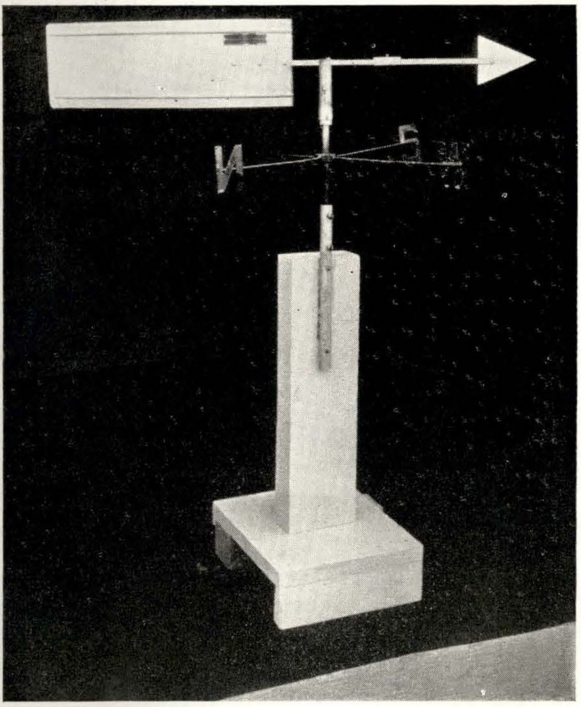


FIGURE A-7.—Region 6 wind vane.

Rain Gages

U. S. Weather Bureau Standard Rain Gage.—The U. S. Weather Bureau standard rain gage has greater capacity and is of more rugged construction than the Forest Service type shown in figure A-8. It has a capacity of 2 inches in the measuring tube and about 22 inches additional in the overflow can. It consists of three parts, the receiver, overflow can, and measuring tube. The receiver mouth is 8 inches in diameter, made of heavy brass machined to a sharp edge at the top. A funnel, fastened 2⅜ inches below the top edge of the receiver rim, directs the rainfall into the measuring tube. The receiver fits over and rests on top of the can which is made either of sheet copper or galvanized sheet iron. The inner measuring tube, 2.53 inches in diameter and 20 inches high, is made of lacquered seamless brass tubing closed at the bottom. As the cross-sectional area of the measuring tube is exactly 0.1 that of the receiver, the rainfall is concentrated for measuring to 10 times its actual depth. The only disadvantage of this gage is its cost, $8.50 to $25.

Forest Service Type Rain Gage.—Tests at the Northern Rocky Mountain Forest and Range Experiment Station and elsewhere have shown that the Forest Service type rain gage (fig. A-8) is equal in accuracy to two other much more expensive standard type gages for use where large capacity or great ruggedness is not needed. It has a capacity of 0.5 inch in the measuring tube and 6 inches in the overflow can.

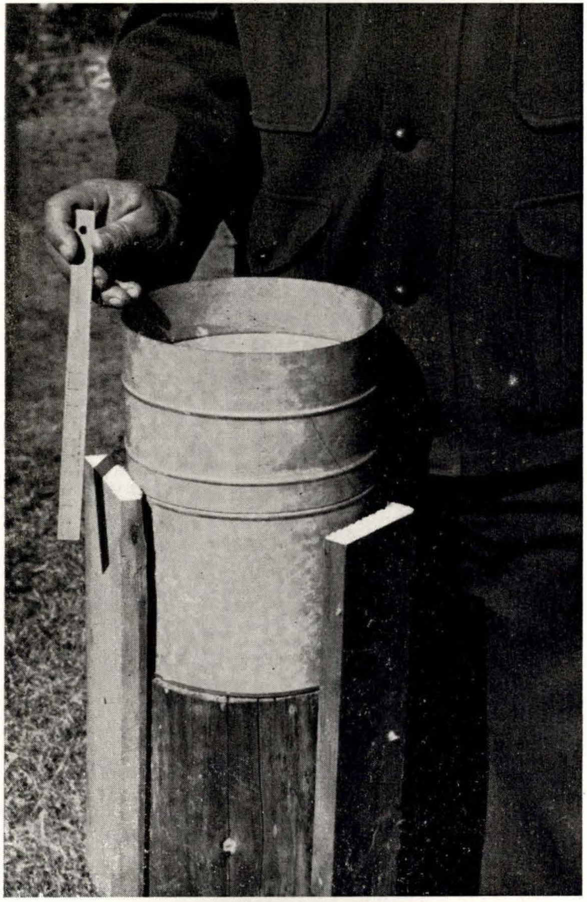


FIGURE A-8.—Forest Service type rain gage.

This gage is similar to the Weather Bureau standard pattern except in size and materials. The 6-inch-high receiver and 7-inch-high overflow can are 7.64 inches in diameter and made from 26-gage galvanized sheet iron. The funnel which directs the water into the measuring tube is fastened 2 inches below the receiver rim. The measuring tube is made from 2.416-inch diameter standard size seamless brass tubing closed at one end by a brass disk. All joints are soldered. The gage requires careful handling to avoid bending the receiver, which impairs its accuracy.

The main advantage of this type is low cost, about $2.50 to $5 for single gages, less if purchased in quantity.

Rain-Measuring Sticks.—Rain concentrated in the measuring tube of either the Forest Service or Weather Bureau type of rain gage is measured by a thin wooden stick graduated in hundredths of inches. As the rain is concentrated to 10 times the actual depth, 0.1 inch on the stick equals 0.01 inch of rain, and 1 inch on the stick equals 0.10 inch of rain. The sticks should be replaced if they become dirty, greasy, illegible, or broken. The short stick, for the Forest Service type gage, is made of sweetgum heartwood and has the graduation stamped with indelible ink. The longer stick, for the Weather Bureau type, is made of Eastern redcedar and has the graduation cut into the wood with a die and inked.

The short sticks cost 10 cents, and the long ones 34 to 50 cents each.

Rain-Gauge Support.—A level, firm support is necessary for accurate rain gaging and to protect the gage from being blown or knocked over and damaged. Figure A-9 shows a type of support that is widely used with the Forest Service type gage. However, slabbing the sides of the post is not always necessary (see figure A-8).

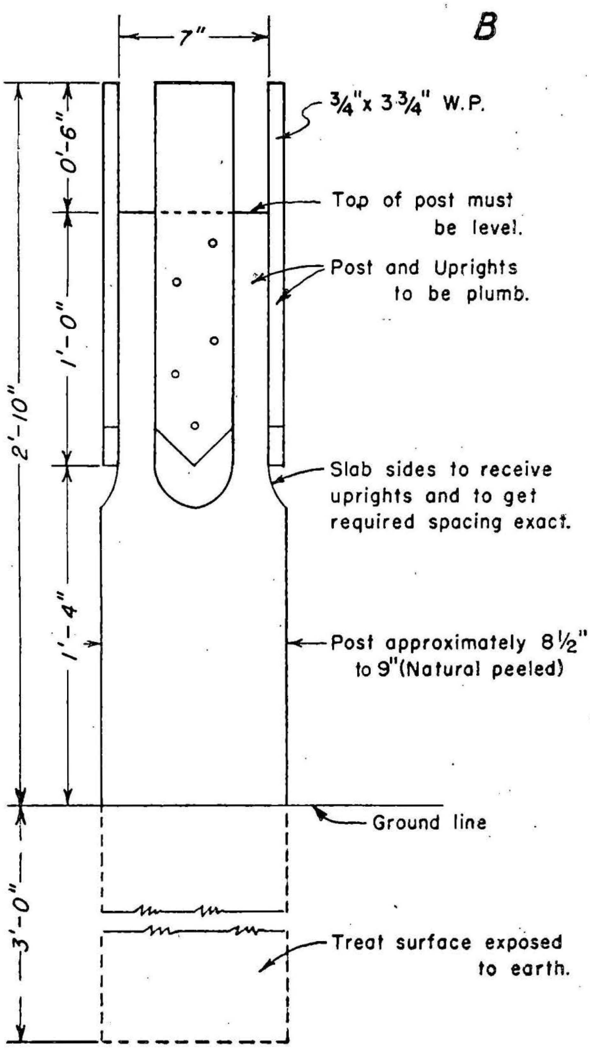

B
7"
3/4" x 3 3/4" W.P.
Top of post must be level.
Post and Uprights to be plumb.
Slab sides to receive uprights and to get required spacing exact.
Post approximately 8 1/2" to 9"(Natural peeled)
Ground line
Treat surface exposed to earth.
0'-6"
1'-0"
2'-10"
1'-4"
3'-0"

FIGURE A-9.—Plans for constructing Forest Service type rain-gage support.

Measuring Relative Humidity

Psychrometers.—The most accurate field method of measuring relative humidity is with a psychrometer, which consists of two thermometers, usually mounted on a stainless metal back. One thermometer, known as the wet-bulb, usually projects below the other, and is covered by a muslin wick. The other is the dry-bulb. To measure relative humidity, the muslin wick is wetted with clean water and air is circulated rapidly (16 feet per second is optimum) past both bulbs either by a fan, by whirling the device, or by suction. The temperatures shown by the two thermometers can then be used to determine relative humidity from suitable psychrometric tables.

Several available types of psychrometers are suitable for use in fire control work. No psychrometer should be accepted if the two thermometers do not agree within one-half of 1° F. when both are dry. Thermometer tubes should be attached in such a way that they can be replaced with a screwdriver.

1. The U. S. Weather Bureau standard type is 12 inches long and consists of two mercury-in-glass thermometers graduated in whole degrees and mounted on a rigid metal back. It is commonly used as a sling psychrometer (fig. A-10, upper right) and whirled by a handle linked to the metal back. This type is especially suitable for stations where it does not have to be transported and there is no ventilated instrument shelter within which the measurements might be taken. It is too fragile for general field use, and cannot be operated inside the limited space of a weather shelter unless converted to a fan type, as shown in figure A-10, lower left, or attached to one of several standard whirling devices.

2. The fan psychrometer (fig. A-10, lower left) was especially developed for fire control work. It consists of a wooden base on which is mounted a metal bracket supporting a Weather Bureau standard type psychrometer, a fan and hand-operated rotating device, and a water bottle. A wick extends from the wet-bulb into the water bottle. A well-designed fan psychrometer should have at least a half-inch of space between the wet-bulb and the top of the water bottle to minimize the possibility that the water temperature will affect the wet-bulb temperature.

Special advantages of the fan psychrometer are:

A. Since the thermometers are stationary, operational breakage is minimized.

B. The operator can watch the thermometers continuously to detect accurately the minimum wet-bulb temperature.

C. It can be used inside an instrument shelter. This feature makes it especially adapted to testing hygrographs within shelters.

The disadvantages are:

A. It is inconvenient to operate where there is no firm base on which to rest it.

B. It is too bulky and fragile for such field use as checking humidity on the fire line.

Region 9 has developed a special fan psychrometer, replacing the manually operated fan with a 4-inch rubber-blade automobile defrosting fan operated by four dry cells. Details can be obtained from the Regional Forester, Milwaukee, Wis.

3. The pocket sling psychrometer (fig. A-10, upper left) is similar in pattern to the Weather Bureau standard type, but smaller, and is equipped with a rigid, metal-lined, leather case. The mercury-in-glass thermometers are graduated in whole degrees. The metal back is connected to the whirling handle by a short chain. Its small size and protecting case make this type the ideal field instrument where pocket portability is desired. Like other sling types, however, it is not adapted for use inside an instrument shelter.

4. A type suitable for general fire control use is the hand-aspirated psychrometer (fig. A-10, lower

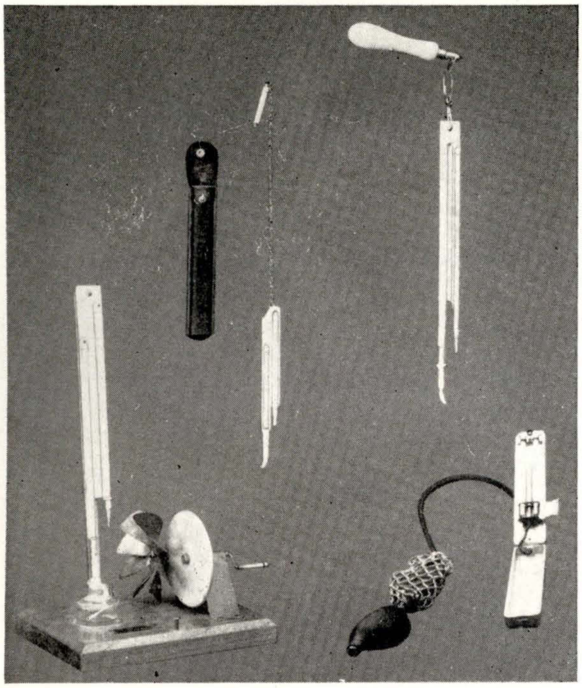


FIGURE A-10.—Four types of psychrometers: Upper left, pocket sling type with case; upper right, Weather Bureau Standard sling; lower left, fan type; lower right, hand-aspirated type.

right). The two mercury-in-glass thermometers, graduated in whole degrees, are securely mounted inside a folding bakelite carrying case which protects the thermometers and minimizes breakage. To operate, air is pumped from a rubber aspiration bulb on the end of the rubber tube into a cotton netting-covered pressure tube from whence it passes through a jet between the thermometers which draws outside air over the thermometer bulbs. It is convenient to use in any situation and its compact case, 8x1½x¾ inches, makes it readily portable. Its main disadvantage is the rapid deterioration of the rubber parts which are expensive to replace.

Approximate retail costs of the four types are:

Weather Bureau standard sling	$ 5.00-$ 7.50
Fan	7.50- 15.00
Pocket sling	7.50- 10.00
Hand-aspirated	14.25

Psychrometer Wicking.—Only clean, unsized, braided cotton tubing should be used for wet-bulb wicks on all types of psychrometers. Wicking should be cut to size—about 3 inches long—and put up in envelopes, about 10 wicks per envelope, for convenient field use. It is sold in gross-yard spools at about $1.10 per spool. One gross yards make 1,728 wicks 3 inches long.

Psychrometer Tables.—Psychrometer tables are used to determine relative humidity from paired readings of the wet- and dry-bulb temperatures. As atmospheric pressure affects the rate of evaporation and consequently the cooling of the wet-bulb thermometer, separate tables are issued for different pressure ranges. Since pressure differs markedly with elevation, the tables to use at any specific station depend on its elevation. The appropriate tables for different elevations are:

Station Elevation (Feet)	*Table for Pressure of:* (Inches of mercury)
Less than 500 feet	30
500 to 1,999 feet	29
2,000 to 3,999 feet	27
4,000 to 5,999 feet	25
6,000 to 10,000 feet	23

The tables most commonly used are contained in U. S. Weather Bureau Bulletin 235, "Psychrometric Tables for Obtaining the Vapor Pressure, Relative Humidity, and Temperature of the Dew Point," for sale by the Superintendent of Documents, Government Printing Office, Washington 25, D. C. It includes tables for all the pressures listed above. Abridged tables for each of the specific pressures listed are also available as separates from Bulletin 235. Several U. S. Forest Service regional offices or experiment stations have simplified tables for distribution within their territories.

Weather Instrument Shelters

Weather Instrument Shelter (U. S. Weather Bureau Cotton-Region Type).—The cotton-region type of shelter is a ventilated shelter designed for the correct exposure and adequate protection of weather instruments that measure atmospheric factors such as air temperature and humidity. It is especially suitable for headquarters weather stations and stations maintained in cooperation with the U. S. Weather Bureau. It is not suitable for use as a weighing shelter because it does not offer protection from wind. It is too expensive for general use.

A substantially built shelter with louvered sides, back, and door, it is 30 inches wide, 20 inches deep, and 33 inches high at the front. Cost, about $35, ready-made.

Weather Instrument Shelter, Region 6 Type.—This shelter (fig. A-11) is a ventilated shelter similar to, but slightly larger than the cotton-region type and is built from stock materials throughout to reduce cost. It is suitable for exposing temperature- and humidity-measuring instruments, and is also used to weigh fuel-moisture sticks with the fuel-moisture scale described in this section. A hole in the floor

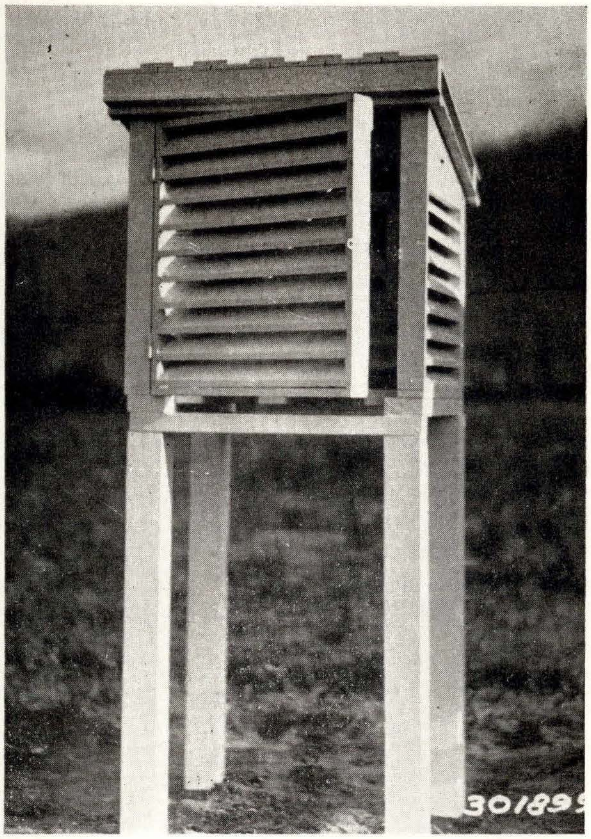


FIGURE A-11—Region 6 type weather-instrument shelter.

allows the sticks to hang through beneath the scales. As it is a ventilated shelter, wind might sometimes interfere with accurate weighing. To facilitate transportation, the shelter is built in six separate sections, consisting of roof, three sides, floor, and door, which are readily assembled. Size: 33½ inches wide, 30 inches deep, and 35 inches high. The louvered slats are set about 1¾ inches apart at a 45° angle. The double roof protects the interior from abnormal heating.

Weather Instrument Shelter, Region 1 Type.—The Region 1 type instrument shelter is a ventilated type suitable for the exposure and adequate protection of weather instruments that measure the condition of freely circulating air. The double roof prevents abnormal heating of the interior. It can also be used to weigh fuel-moisture-indicator sticks with triple-beam type balances. It cannot be used for weighing sticks with the Region 6 or Appalachian type scale. Its special advantage over the louvered types is low cost for materials and especially labor. Working drawings, including bills of materials and instructions for assembling, can be obtained from the Northern Rocky Mountain Forest and Range Experiment Station, Missoula, Mont. Materials cost $6 to $8.

Appalachian Type Weighing Shelter.—The Appalachian weighing shelter was designed to provide a suitable mounting for the Appalachian fuel-moisture scale, where the sticks could be weighed free from wind effects. It is also a convenient housing for batteries, switch, buzzer, rain sticks, and other accessories, as shown in figure A-12. It is recommended for stations using the Appalachian type fuel-moisture scale, but is not suitable for housing thermometers and other instruments that require a ventilated shelter.

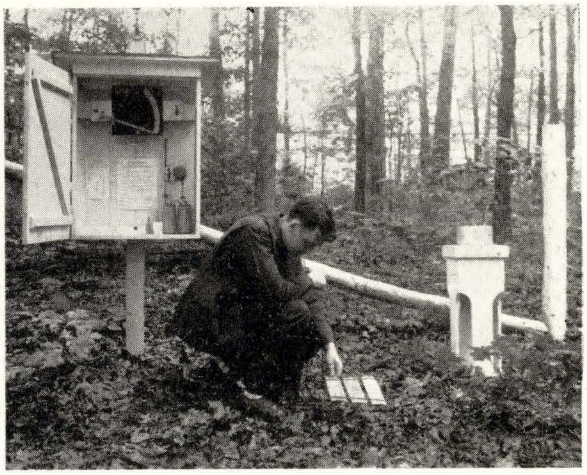


FIGURE A-12.—Appalachian type weighing shelter in typical use.

The shelter consists of a weatherproof box, 36x23 x9½ inches, that should be mounted at convenient height on a 4x4-inch square hardwood post set in a concrete base. The concrete eliminates shifting out of position and vibration due to wind. Details of construction and bill of materials are found in "The Measurement of Forest Fire Danger in the Eastern United States and its Application in Fire Prevention and Control," Technical Note No. 50, Appalachian Forest Experiment Station, Asheville, N. C., which can be obtained free upon request. Materials cost about $6 to $7.

Measuring Visibility

Haze Meter, Byram Type.—The Byram haze meter (fig. A-13) is a simple instrument designed to

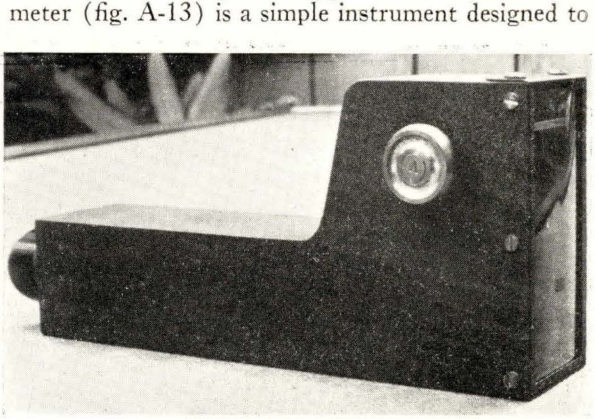


FIGURE A-13.—Byram haze meter.

measure the distance forest-fire observers can detect smoke from small fires under existing atmospheric conditions. It measures the optical density of the atmosphere and expresses the measurements in distance at which a "standard" smoke can be seen. The "standard" smoke is the amount that would emanate on a hot, midsummer afternoon from a fire 10 x 20 feet in Douglas-fir or ponderosa pine duff in Oregon or Washington, or a fire 12 x 12 feet in hardwood leaf litter under dry conditions in the East.

Use of the Byram haze meter requires a succession of ridges or other recognizable topographic targets situated at various distances from the point of measurement. Where these topographic features are present, the meter measures accurately for the atmospheric condition along the line of sight. It is independent of the quality of the observer's eyesight, and can be used on bright or dull days, in any direction, against any background, but not in flat country or where nearby mountain ridges obscure the topographic features near the limit of visibility for small smokes.

The Byram haze meter is roughly 9 inches long, 3 inches high, and 1¾ inches wide. Cost, $22.50 complete with case.

Haze Meter, Plains Type.—This haze meter was especially designed for measuring the distance at which small smokes can be seen in flat or rolling country. It utilizes small dark targets relatively close to the observer, such as the shady side of a clump of trees or small ridge. Externally it resembles the Byram haze meter (fig. A-13) except that it does not have the knob marked "A." Like the Byram haze meter, it measures the optical density of the atmosphere along the line of sight and expresses the measurements in units which are readily convertible by the use of a table supplied with each instrument into the distance at which a small smoke may be seen. The small "standard" smoke is the same as for the Byram meter. Tables can be constructed for other standard-sized smokes, however, without changing the calibration.

Although designed for non-mountainous country, it can also be used in the mountains where suitable targets are available, such as the shady side of clumps of trees not more than 2° below the horizon nor more than 2 miles away, or the shady side of ridges not more than 2° below the horizon and preferably not more than 5 miles away. It is not suitable for measuring visibility in deep valleys or canyons surrounded by high mountains. Cost, complete with case, $29.85.

Dark-Ridge Visibility Chart.—There is a definite relationship between the distance at which a smoke and a black object can be seen. As distant tree-covered ridges approximate a black body, the extreme distance at which a dark ridge is visible provides a good index of the distance at which a smoke can be seen. The chart (fig. A-17) prepared by the Northern Rocky Mountain Forest and Range Experiment Station, shows the relation between dark-ridge visibility distance and the distance at which a dense smoke ½-foot in diameter, rising and spreading normally, can be seen.

The chart is used as follows: If a ridge 22 miles away is visible but the next ridge beyond, known to be 26 miles distant, is not, then dark-ridge visibility is estimated at 24 miles. Figure A-17 shows that a small smoke can be detected up to 9.4 miles under such conditions.

This method is applicable in mountainous terrain where a reasonable succession of ridges can be seen from the observation point. It is most reliable when the ridges are covered with coniferous trees or hardwoods in leaf, but satisfactory results can be obtained even with ridges having a cover of leafless hardwoods. Likewise, it is most accurate when the terrain and smokes are uniformly lighted, as on clear days, uniformly cloudy days, or just after sunset. Satisfactory results, however, can be obtained on most partly cloudy days. On such days, the results apply to smokes in sunlight.

This chart cannot be used in non-mountainous country.

Note: Page numbers A-9 to A-12 and figures numbers A-14 to 16 are missing.

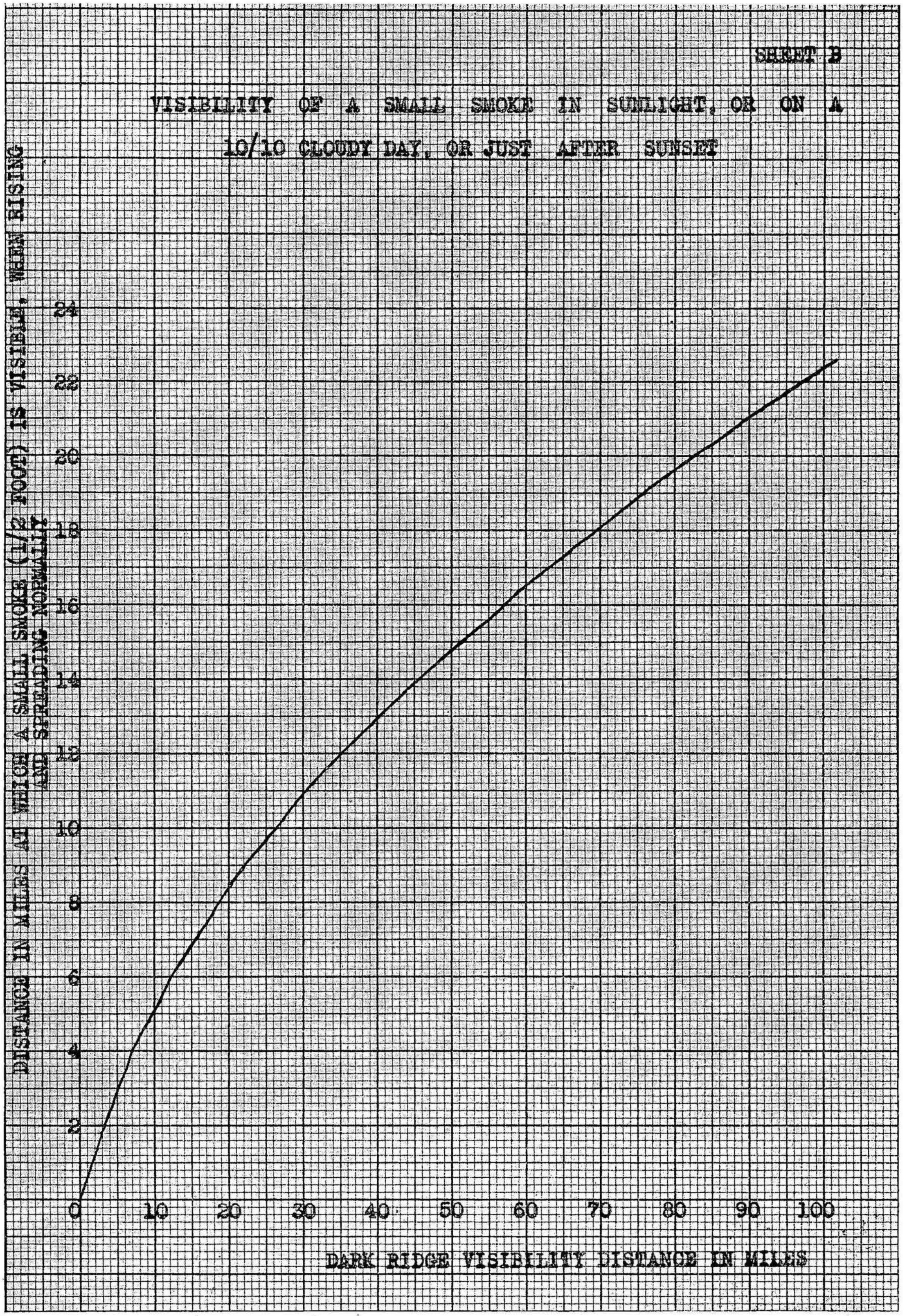
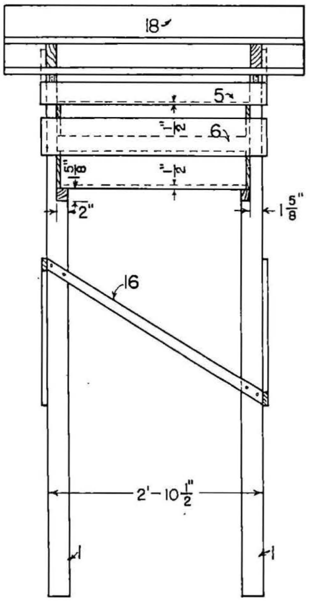
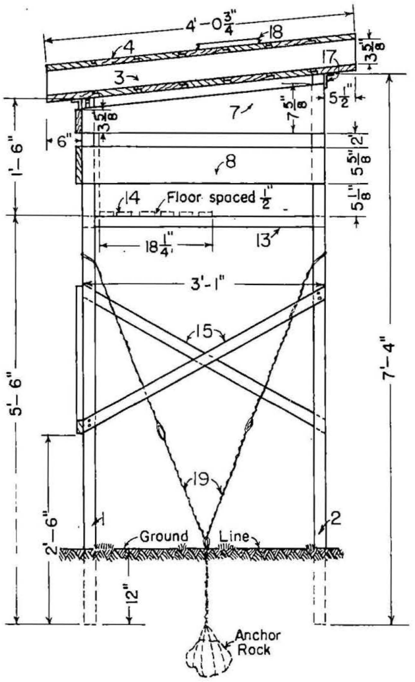


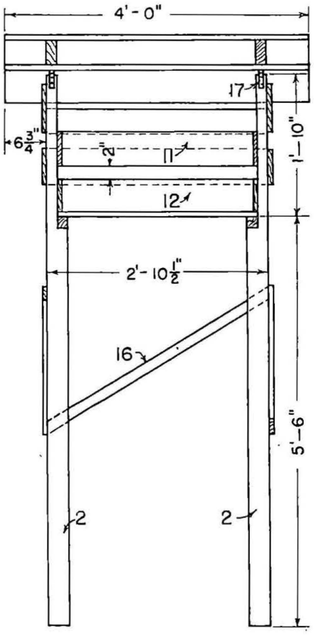
FIGURE A–17.— Chart for converting dark-ridge visibility distance to small-smoke visibility distance.


18
5
$\frac{1}{2}''$
6
$\frac{1}{2}''$
$1\frac{5}{8}''$
$2''$
$1\frac{5}{8}''$
16
$2'-10\frac{1}{2}''$
1
1

REAR VIEW


$4'-0\frac{3}{4}''$
18
4
3
17
$3\frac{5}{8}''$
$7\frac{5}{8}''$
$5\frac{1}{2}''$
7
$3\frac{5}{8}''$
6"
$1'-6''$
8
$\frac{1}{2}''$
$5\frac{5}{8}''$
14
Floor spaced $\frac{1}{2}''$
$5\frac{1}{8}''$
$18\frac{1}{4}''$
13
$3'-1''$
15
$7'-4''$
$5'-6''$
19
$2'-6''$
1
2
Ground
Line
12"
Anchor Rock

SIDE VIEW


$4'-0''$
17
$6\frac{3}{4}''$
2"
11
12
$1'-10''$
$2'-10\frac{1}{2}''$
16
$5'-6''$
2
2

FRONT VIEW

BILL OF MATERIAL

Item	No. Pcs.	Size	Material	Use
1	2	$1\frac{5}{8}''$ X $3\frac{5}{8}''$ X $7'-\frac{1}{4}''$	Pine S4S	Legs
2	2	$1\frac{5}{8}''$ X $3\frac{5}{8}''$ X $7'-4''$	'' ''	''
3	2	$1\frac{5}{8}''$ X $3\frac{5}{8}''$ X $4'-2''$	'' ''	Rafters
4	14	$\frac{25}{32}''$ X $7\frac{1}{2}''$ X $4'$	'' ''	Roof (shiplap)
5	1	$\frac{25}{32}''$ X $3\frac{5}{8}''$ X $3'-\frac{1}{16}''$	'' ''	Back (outside)
6	1	$\frac{25}{32}''$ X $5\frac{5}{8}''$ X $3'-\frac{1}{16}''$	'' ''	'' ''
7	2	$\frac{25}{32}''$ X $7\frac{5}{8}''$ X $3'-1''$	'' ''	Sides ''
8	2	$\frac{25}{32}''$ X $5\frac{5}{8}''$ X $3'-1''$	'' ''	'' ''
9	2	Same	'' ''	'' (inside)
10	2	Same	'' ''	'' ''
11	1	$\frac{25}{32}''$ X $5\frac{5}{8}''$ X $2'-5\frac{22}{32}''$	'' ''	Back ''
12	1	Same	'' ''	'' ''
13	2	$1\frac{5}{8}''$ X $2''$ X $3'-1''$	'' ''	Floor Supports
14	6	$\frac{25}{32}''$ X $2\frac{5}{8}''$ X $2'-5\frac{22}{32}''$	'' ''	Floor
15	2	$\frac{25}{32}''$ X $1\frac{25}{32}''$ X $3'-9''$	'' ''	Side Braces
16	1	Same	'' ''	'' ''
17	8	$\frac{5}{8}''$ X $2''$	Plain Steel	Inside Corners
18	9 Lin. Ft.	32" Heavy	Roofing	Roof
19	60'	#12 Gal. Iron	Wire	Anchor

ASSEMBLY INSTRUCTIONS

Item No. 1 - Rip one end to $1\frac{5}{8}''$ X $1\frac{5}{8}''$ X $1'-7\frac{5}{8}''$, cut to roof pitch.

Item No. 2 - Rip one end to $1\frac{5}{8}''$ X $1\frac{5}{8}''$ X $1'-11\frac{5}{8}''$, cut to roof pitch.

Item No. 13 - Attatch with 10d. finish nails to items 1 - 2.

Nail items 9-10-11-12 before items 7 - 8.

Items 9 - 11 - Space 2" above 10 - 12.

Items 6 - 8 - Space $5\frac{1}{8}''$ above 13.

Items 5 - 7 - Space 2" above 6 - 8.

Item 10 - Attatch with 8d. finish nails to 1 - 2.

Items 11 - 12 - Attatch with 8d. finish nails to 9 - 10.

Items 15 - 16 - Attatch with #9 X $1\frac{1}{4}''$ screws to 1 - 2.

Item 7 - Rip or taper from $7\frac{5}{8}''$ at one end to $3\frac{5}{8}''$ at other.

Item 14 - Space $\frac{1}{2}''$ and nail with 8d. finish nails to 13.

Item 3 Cut proper length and bevel to roof pitch, nail item 4 on both sides, see "side view". Cut roofing to approx. size, lap and fasten with roofing nails and cement to upper deck, crimp edges all around and nail.

Place roof on top of frame and fasten as shown with "inside corners" of $\frac{5}{8}''$ X 2" plain steel.

Item 19 On lookouts and in other windy places anchor shelter from all four legs to one central anchor with #12 gal. iron wire, twisted as shown.

Note: Follow these instructions carefully or shelter will not assemble properly.

FIRE-WEATHER INSTRUMENT SHELTER

R-1 TYPE

L.G.G.— U.S.F.S., W.O., 1947

SECTION B

DETECTION EQUIPMENT

Alidade, Plain-Base, 18-Inch.—A plain-base brass alidade having a 10-inch rear sight with two 4- by 1/64-inch apertures, and a 5½-inch front sight with 4-inch opening containing sight hair. This alidade is for use with the plain type of lookout map board, or with a map sketching board. Approximate cost, $15.

Alidade, Vertical-Angle.—A simple, inexpensive instrument for measuring vertical angles from lookouts equipped with Bosworth or other fire finders without vertical-angle attachments. (Fig. B-1).

Consists of a felt-bottomed iron bracket carrying a movable sighting arm and vertical pendulum. The sighting arm carries peep sight, horizontal front sight, and photographic print of scale with ½° graduations. The pendulum is suspended on the same axis as the sighting arm. It carries an index pointer and lead weight on lower end to increase stability and reduce frictional errors. The instrument is accurate within approximately ¼° plus or minus. The base need not be leveled to function accurately. Overall height, 9½ inches; length of sighting arm, 13 inches. Figure B-2 shows a side view of the instrument. Approximate cost, $2.50.

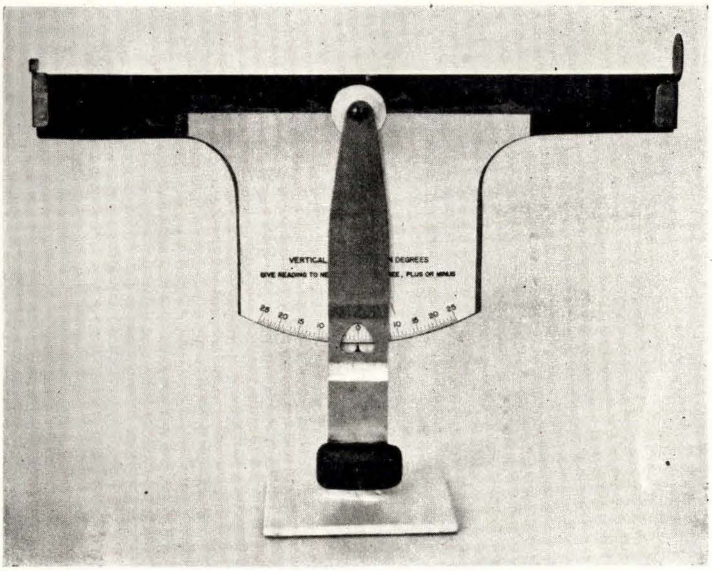


FIGURE B-1.—Vertical-angle alidade.

Map Board, Lookout, Koch.—The lookout map baseboard, or Koch board, is simply a plain wooden baseboard, 24 x 30 inches in size, with an orienting arm against which the lookout map board can be placed for orienting purposes. See plan at end of this section. The orienting arm works back and forth in a slot for the purpose of orienting the lookout board. When once oriented, the arm is held permanently in place by means of a bolt which is passed through the outer end of the arm and a slot in the baseboard and secured by a wing nut.

Like the lookout map board, the baseboard can be manufactured according to plan by any carpenter. Approximate cost, $2.

Map Board, Lookout, Wood.—A plain wood map or drawing board provided with rabbeted hardwood end strips and a softwood or plywood center inlay. Size of the board is 20 by 28 inches. The hardwood end pieces and the softwood inlay are for the purpose of preventing warping and splitting when exposed to the weather. See plan at the end of this section. This board may be manufactured by any good carpenter by following the plan carefully. Approximate cost, $1.50.

Fire Finder, Osborne.—An instrument designed for use by lookouts in determining location and size of fires discovered (fig. B-2). It can easily be set up, oriented, adjusted, and used by unskilled men, following simple directions. The instrument consists of:

1. A redwood baseboard with three parallel tracks for shifting center as necessary to dodge obstructions, without disturbing orientation.
2. A lower plate with grooves and leveling screws, machined to fit tracks, and center bearing for upper plate.
3. An upper plate which carries on its outer edge an engine-divided azimuth graduation of transit precision.
4. A sight ring which revolves around shoulder on upper plate and carries the sights, a 1-minute vernier, and a guard to prevent erroneous readings. The rear sight has a scale and a peep slide for reading vertical angles from 3° plus to 20° minus. Stretched between the sights is a graduated steel tape for defining the line of sight and scaling the distance on the map. Horizontal angles can be read accurately to 2′; vertical angles to 4′.
5. A galvanized-iron map disk, 20-5/16 inches in

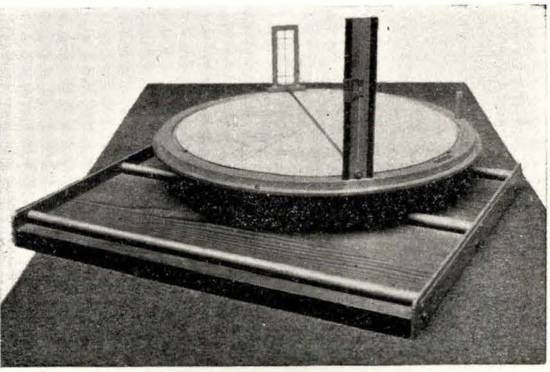


FIGURE B-2.—Osborne fire-finder.

diameter, held to upper plate by a center pin and six flat-headed screws.

6. A 4-inch, graduated, spirit level, sensitive to about 1′ to one division, for leveling instrument.

Shipping weight, 85 pounds.

The instrument may be mounted on a wood fire-finder stand or cabinet, constructed locally, or on an iron pedestal designed for the purpose. Rigidity of mounting is essential. Approximate cost, $75. Repair parts for this instrument may be secured from Leupold and Stevens, Portland, Ore.

Stand, Fire-Finder.—This stand was designed primarily for the Osborne fire finder, but can be used with other fire finders or a map board. Size 19 by 22 inches. The plan at the end of this section shows a height of 38 inches, but this may need to be increased in some locations to permit taking all vertical angles.

The frame is enclosed with plywood on three sides, and there are two plywood shelves, which, with the floor space beneath the stand, provide ample space for forms, stationery, telephone batteries, and other articles. Opposite the open side is a recessed space for a telephone. If desired, however, the plywood may be extended to the top of the frame on that side and the telephone fastened to any of the enclosed sides. The side space is also useful for hanging maps, telephone directory, etc.

All pieces are joined with wood screws, so that the stand will remain rigid. Provision is made for securing the stand to the lookout house floor with lag screws. Where ready-cut houses are purchased, material as listed in the specification for the stand may be included. Approximate cost, $10.

Table, Fire-Finder Map-Board.—An efficient but inexpensive and easily constructed map-board table designed and used by the Texas Forest Service. (See fig. B-3.) All material is No. 1 southern yellow pine with the exception of the ¼-inch fir plywood on the sides and bottom of the compartment housing the telephone and tower report forms. Nails and screws are used in its construction. The table has stood the test of lookout work. Materials cost $5.15, including $4 for lumber and $1.15 for 3-inch strap hinges, hasp, and paint. Labor required for construction, approximately one man-day. The dimensions of the table are:

(a) Top—37 inches square, including ½-inch molding all around.
(b) Height to top of table—45 inches.
(c) Height to top of compartment—44 inches.
(d) Height to bottom of compartment—31 in.
(e) Dimensions of compartment—8 by 12 inches.
(f) Spread of table legs at bottom—35 inches.
(g) Spread of table legs at top—19 inches.
(h) Legs 2 x 4 inches at top, tapering to 2 x 2 inches.

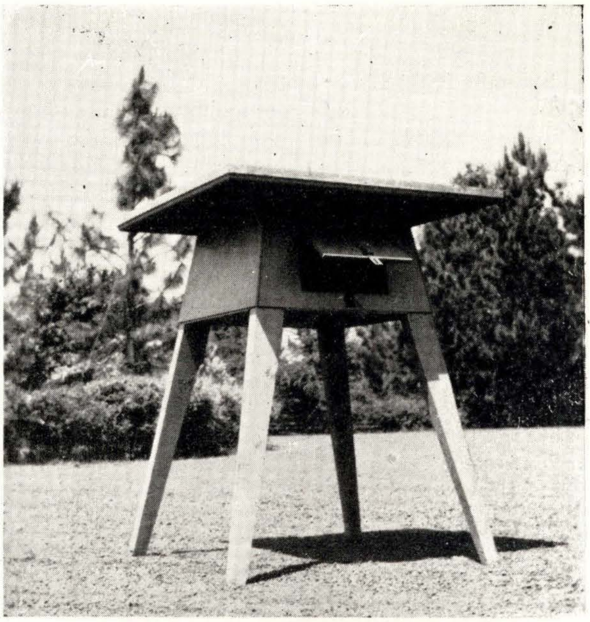


FIGURE B-3.—Fire-finder map board table. (Used by Texas Forest Service.)

Goggles, Glare-Reducing.—Designed especially for use by lookout men to overcome eyestrain. Frames are of corrosion-resistant metal, adjustable to individual requirements and designed for comfort. Glasses are neutral tint, with transmission of visible radiation from 25 to 30 percent, and optically finished to eliminate all distortion. Investigation has shown that practically all cheap colored goggles cause eyestrain because of imperfections in the glass used.[1] Approximate cost, $5.45.

Binoculars.—Prismatic type, 6 by 30 power. For use by lookout men in distinguishing between true and false smokes, in confirming the presence or absence of smoke under suspicious circumstances, and in locating small smokes after lightning storms. Since study of the use of instruments of higher than 6 by 30 power indicates that they offer few advantages and many disadvantages, their use for fire-detection purposes is not desirable. Approximate cost, $67.50.

Candle, Test-Smoke.—Designed to simulate as nearly as possible the smoke from a small forest fire (approximately 200 square feet in Douglas-fir duff). Length 7 inches, diameter 1-7/16 inches. Weight approximately one pound. Cost about $3.25 per dozen. Emits smoke for a period of 4 to 5 minutes.

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[1] McArdle, R.E., and Byram, G. M. Goggles for increasing the efficiency of forest fire lookouts. Jour. Forestry 34:797-801, illus. 1936.

Smoke from a single candle can be seen against a dark background 15 to 17 miles on the clearest days. Used as standard smoke in calibrating the Byram visibility meter, it can help check efficiency of lookout men and in making visibility tests. However, it does not duplicate a natural smoke under all conditions and convection currents to carry the smoke upward are lacking.

Experience in at least two regions has shown that the candle has definite value for the purposes indicated, and is very convenient to use, is reasonably safe in dry weather, but should be wrapped in a wet sack or placed in a metal container at time of lighting. Ordinarily the candle is lighted on the ground and held aloft on a long pole.

Figure B-4 illustrates the smoke volume created by a single candle. Because the smoke is heavy and does not rise to any great height, the candles have little practical value in heavy timber stands.

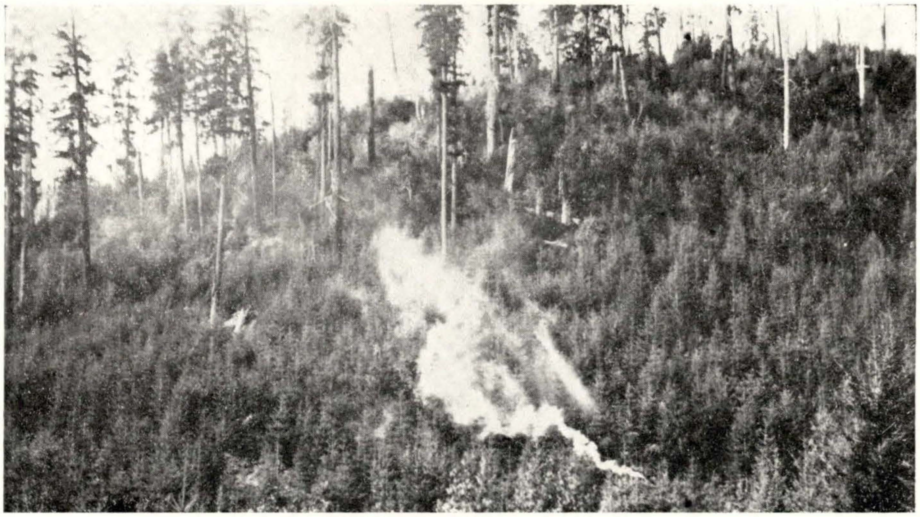
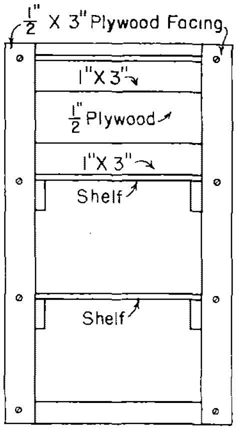
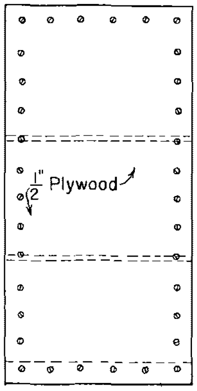


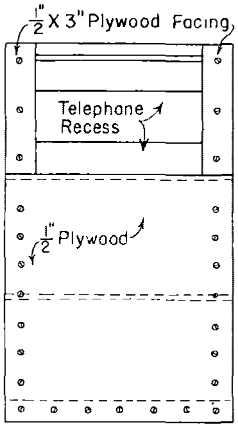
FIGURE B-4.—Smoke from test candle.


1/2" X 3" Plywood Facing
1"X 3"
1/2 Plywood
1"X 3"
Shelf
Shelf

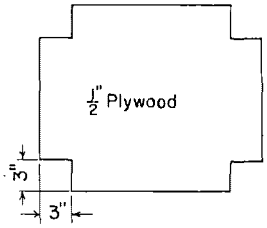
FRONT



SIDE

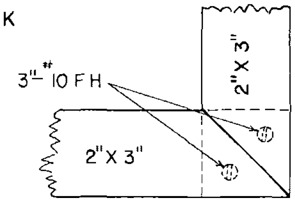

1/2 X 3" Plywood Facing
Telephone Recess
1/2 Plywood

BACK

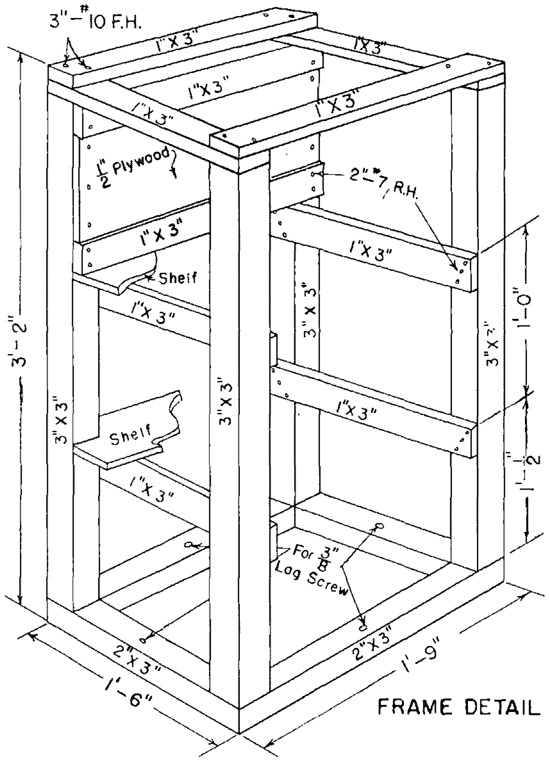

1/2 Plywood
3"
3"

SHELF

2 Required

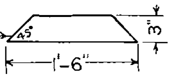
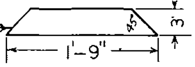

3"-#10 F H
2"X 3"
2"X 3"

CORNER DETAIL (Bottom)


3"-#10 F.H.
1"X3"
1"X3"
1"X3"
1"X3"
1"X3"
1/2 Plywood
2"-#7 R.H.
1"X3"
1"X 3"
Sheif
1"X 3"
1"X3"
3'-2"
3"X3"
3"X3"
3"X3"
3"X3"
1'-0"
Shelf
1"X3"
1'-2"
For 3/8" Lag Screw
2"X3"
2"X3"
1'-6"
1'-9"

FRAME DETAIL

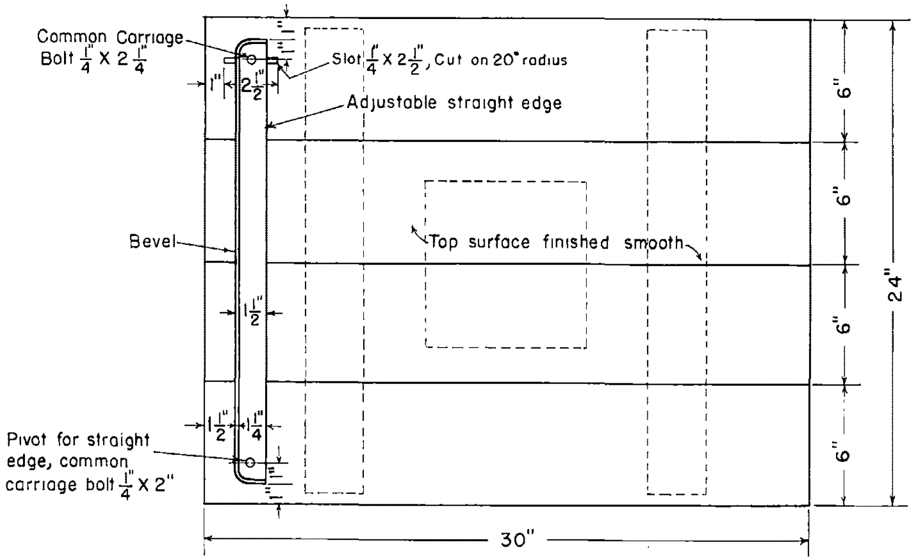
MATERIAL LIST

3"X3"net.	4pc	2'-10"	Posts
2"X3"net.	2pc.		
2"X3"net	2pc		
1"X3"net	4pc	1'-9"	Top & Back
1"X3"net	6pc	1'-6"	Top & Sides
1/2 Plywood	2pc.	0'-3" X 1'-1"	Back
" "	2pc	0'-3" X 3'-2"	Front
" "	2pc	1'-6" X 1'-9"	Shelves
" "	2pc	1'-6" X 3'-2"	Sides
" "	1pc	1'-10" X 2'-1"	Back
" "	1pc	5" X 1'-9"	Back (Recess)

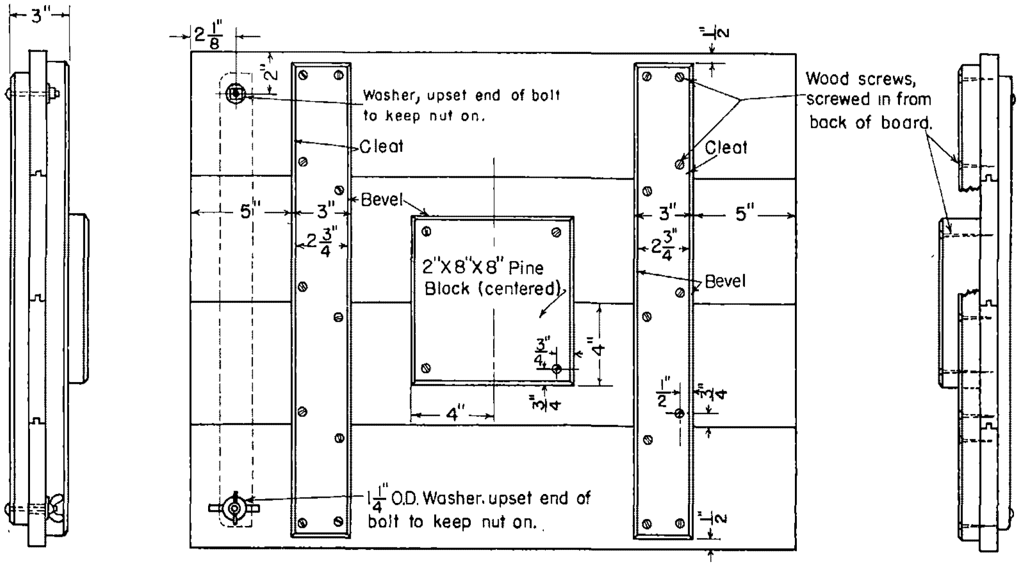
Wood Screws 16 – 3"X#10 F.H
" " 32– 2"X#7 R H
" " 115– 1"X#7 R.H.
Lag Screws 4 – 3/8"X4 1/2" S H.

FIRE FINDER STAND

LGG.-USFS,WO,1947


Common Carriage Bolt $\frac{1}{4}$" X 2$\frac{1}{4}$"
Slot $\frac{1}{4}$" X 2$\frac{1}{2}$", Cut on 20" radius
1"
2$\frac{1}{2}$"
Adjustable straight edge
Top surface finished smooth
Bevel
1$\frac{1}{2}$"
1$\frac{1}{2}$"
1$\frac{1}{4}$"
Pivot for straight edge, common carriage bolt $\frac{1}{4}$" X 2"
6"
6"
6"
6"
24"
30"

TOP VIEW

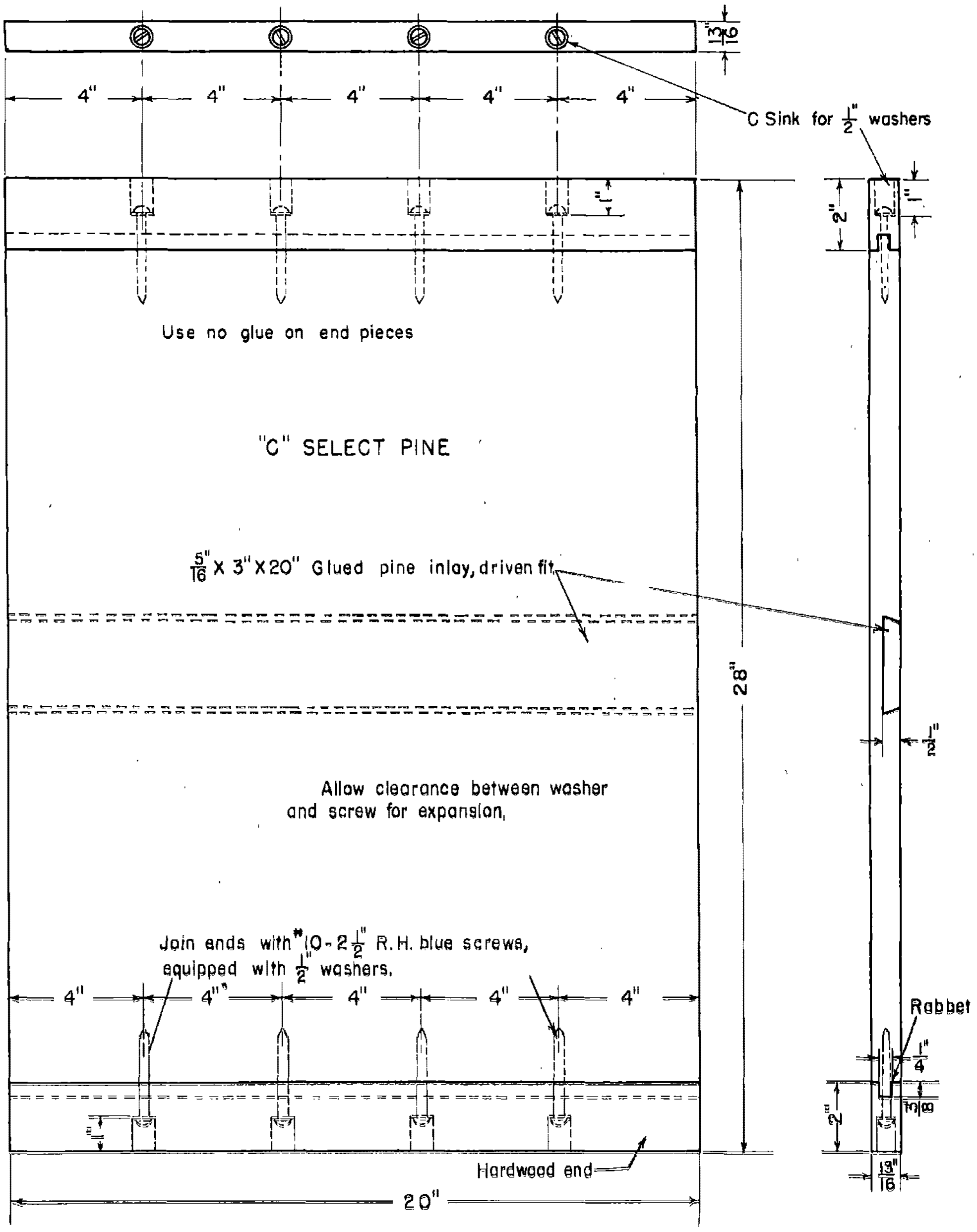

3"
2$\frac{1}{8}$"
2"
$\frac{1}{2}$"
Washer, upset end of bolt to keep nut on.
Cleat
Bevel
5"
3"
2$\frac{3}{4}$"
2"X8"X8" Pine Block (centered)
$\frac{3}{4}$"
4"
4"
$\frac{3}{4}$"
Wood screws, screwed in from back of board.
Cleat
3"
5"
2$\frac{3}{4}$"
Bevel
$\frac{1}{2}$"
$\frac{3}{4}$"
$\frac{1}{2}$"
1$\frac{1}{4}$" O.D. Washer, upset end of bolt to keep nut on.

BOTTOM VIEW

Note: All material to be $\frac{5}{4}$" "C" Select pine, S4S, except fastening block.

LOOKOUT MAP BASE BOARD (KOCH)

L.G.G. - U.S F.S., W.O., 1947


4"
4"
4"
4"
4"
13"/16
C Sink for 1/2" washers
1"
2"
1"
Use no glue on end pieces
"C" SELECT PINE
5"/16 X 3" X 20" Glued pine inlay, driven fit.
28"
1/2"
Allow clearance between washer and screw for expansion.
Join ends with #10-2 1/2" R.H. blue screws, equipped with 1/2" washers.
4"
4"
4"
4"
4"
Rabbet
1/4"
5/8
2"
1"
13"/16
Hardwood end
20"

WOOD LOOKOUT MAP BOARD

L.G.G. - U.S.F.S., W.O., 1947

SECTION C

COMPASS, PROTRACTOR, AND DISPATCHER EQUIPMENT

Compass, Pocket.—A standard pocket compass for use by smoke chasers and others in finding fires (fig. C-1). Case is aluminum, black finish, 3¼ by 3 by ⅝ inches, with white sighting line inside of lid. Ring is graduated anticlockwise from 0° to 360° and provision is made for setting off variation to 30° either east or west. Cost, approximately $5.00

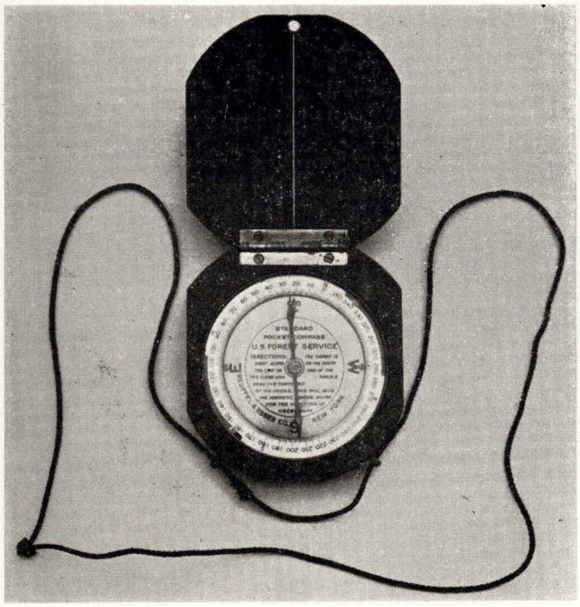


FIGURE C-1.—Standard pocket compass.

Protractor, Dispatcher.—A full 360° protractor, 10 inches in diameter with an extension finger or straightedge which projects the zero line of the protractor to a total distance of 8 inches, or 16 miles on a ½-inch-scale map (fig. C-2). The zero line is slotted, approximately one-tenth of an inch wide, from the outer edge of protractor almost to the center pin to permit the use of a pencil along the entire line of sight. The protractor is graduated anti-clockwise in order to permit turning off direct readings from a meridian line established for any given point upon the map.

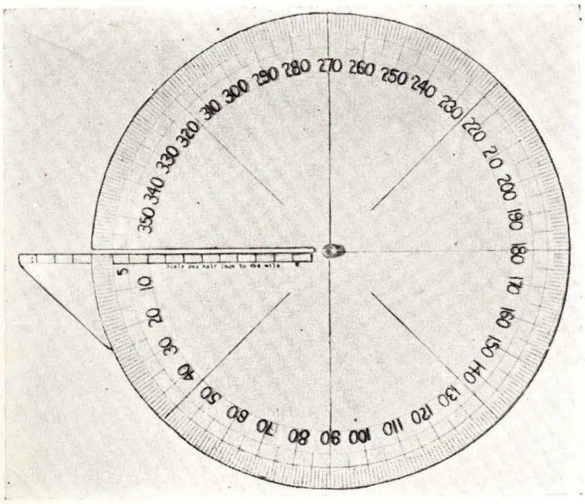


FIGURE C-2.—Dispatcher's protractor.

The protractor is made of heavy, transparent material which does not obscure any part of the map when in use. A 1/16-inch centering hole is provided so that instrument can be used upon a smooth-surfaced map or with a centering pin. Approximate cost, $1.50.

Protractors, Transparent, for Mounting on Maps.—Two types of full-circle transparent protractors are available:

(a) *Visitype*: Made commercially in three sizes, 5 inches, 6 inches, and 8 inches in diameter. Azimuth graduation, with 1° divisions, marked every 10°. Carries directions for mounting. Cost 20 cents for any size.

(b) *Glassine*: Three circles on the same sheet, 8 inches, 16 inches, and 24 inches in diameter. Each circle is divided into degrees and ¼ degrees, with both azimuth and quadrant markings every 10°. The common center of the circles is marked by the crossing of north and south and east and west lines. These protractors are printed by the Government Printing Office and are available to government agencies only.

Reel, Retracting-String.—A device to eliminate the many dangling strings on dispatcher and lookout map boards equipped with transparent protractors. It consists of a spring-winding reel enclosing a braided silk cord. A mounting bracket and tube to conduct the string through a mounted map are also provided. Figure C-3 shows a side view of the reel mounted on the back of a ¼-inch map board. For convenience, a Moore push pin may be fastened to the end of the string. Approximate cost, $2.40.

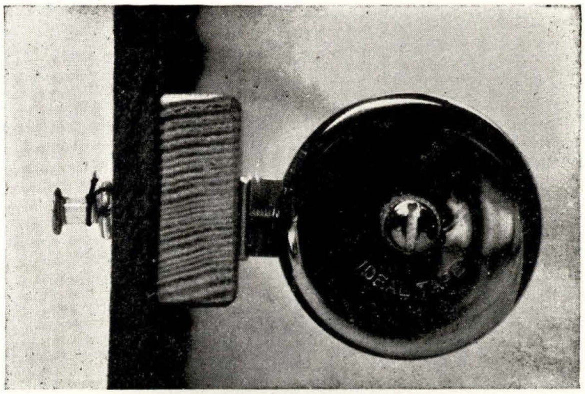


FIGURE C-3.—Retracting string reel.

Protractor, Smoke-Chaser's.—A small transparent protractor for plotting azimuths (fig. C-4). It is made of transparent non-inflammable material, with printing processed for durability, and has an 18-inch length of fishline for extending azimuth readings. The protractor is 4¼ inches square and the azimuth circle is 3⅝ inches in diameter. A township on one-half inch scale, with sections numbered, is located inside the azimuth circle, and a one-half inch square, divided into sixteen small squares, is located in one corner outside the azimuth circle. These features are to facilitate description of locations by legal subdivisions. The north and south edges of the protractor are graduated in inches. A heavy envelope is furnished to protect the protractor when not in use. This article is manufactured at the Forest Service Printing Shop, Alameda, California.

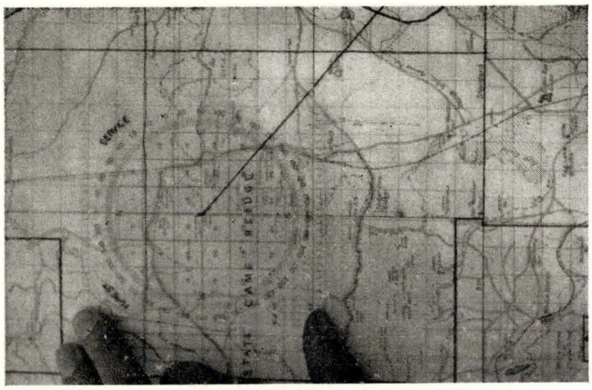


FIGURE C-4.—Smokechaser's protractor.

Printer, Azimuth-Circle.—This article (fig. C-5) was developed for quickly printing azimuth circles on dispatcher and other maps. It has two parts: the printing unit and the inking unit.

The printing unit consists of a printing plate, spring-suspended on a square, flat bronze base, the center of which has been removed. Provision is made for accurately centering and orienting the printing plate. Printing is done by pressing evenly on the center handle, which forces the plate to the map.

The inking unit consists of a rotating ink plate and a spider with three gelatin rollers, the plate being mounted on the supporting frame through a self-aligning ball bearing. The rollers ink the printing plate as it is depressed against them and the inking plate is rotated.

Overall dimensions of the printer are 6¼ by 6¼ by 3¼ inches. The azimuth circle is 4¾ inches in diameter.

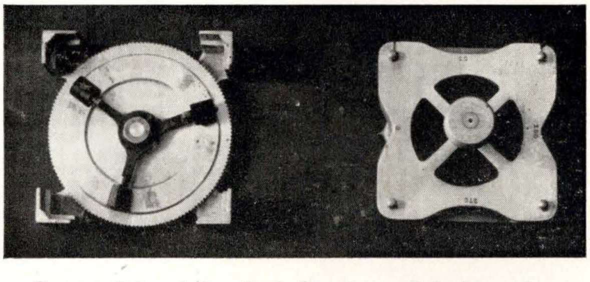


FIGURE C-5.—Azimuth-circle printer. Printing unit at right; inking unit at left.

Map Case, Smoke Chaser's.—Designed for the convenience of smoke chasers in carrying and protecting maps. Inside dimensions, 6 by 9 inches. Made of 12-ounce olive-drab duck. Has flap at top with snap fastener and web loops at back for attaching to belt. Approximate cost, $1.

SECTION D

COMMUNICATION EQUIPMENT

RADIO

General Considerations

The following general discussion is sufficiently complete to serve as a basis for radio communication planning. It merely points out basic considerations relative to selection of types of radiophones, lists certain types that have been produced especially for forestry communication, and indicates developments being made by the U. S. Forest Service. Detailed information on the place of radio in forestry communication is contained in the Forest Service Radio Handbook.

The following minimum basic questions must be answered before an intelligent selection of kinds and types of radio equipment can be made.

1. What is the basic use for the proposed radio system?

(*a*) Fire detection and suppression communication.

Radio systems to meet communication needs are usually installed in protection units where an existing telephone system is maintained for communication between agency personnel or to insure prompt reporting and fire fighting by wardens and local cooperators. The primary purpose is to extend communication from the telephone system to moving personnel and to the fire control line by using key stations in conjunction with automobile and aircraft radio and with light portables carried by suppression forces. A network of light portables can also be extended to key points on the circumference of a fire to keep the fire boss fully informed on the status of control at all points on the fire control line.

Such systems are far less costly than systems requiring automatic repeaters and numerous automobile and headquarters installations, and in general they fill the fire communication needs of most protective units in a satisfactory manner.

Since many of the radiophones used in a system such as described must be man-packed, it is necessary to use AM (amplitude modulated), rather than FM (frequency modulated), equipment throughout the system, because at the present stage of development it is not possible to design extremely lightweight (under 10 pounds) FM equipment.

(*b*) Administrative communication (States or other units).

If in the case of States or other units the need is primarily for administrative communication, then standard police type FM radio systems are recommended.

2. Which of the following listed uses is most important?

(*a*) Communication between lookouts. May be accomplished with any one of several types and classes of equipment (AM or FM).

(*b*) Communication between lookouts and fire suppression crews. Normally dictates an AM system, with lightweight portable equipment for field crews.

(*c*) Communication between lookouts and mobile units (cars and trucks in either fire or special administrative use). May be accomplished with any one of several types and classes of equipment (AM or FM).

(*d*) Communication between mobile units and fixed stations (other than lookouts) such as ranger headquarters or other operation centers. If the need is primarily for such special communication, then standard police type FM radio systems are recommended.

(*e*) Communication between suppression crews. If communication is required between suppression crews on going fires, portable radio sets based on AM frequency are needed.

3. Over what distance in miles must reliable communication be maintained and what is the general nature of the topography in the area involved?

The answer to this question will determine the amount of power needed and the distribution and location of stations required to provide the desired service. The details must usually be left to a qualified communications engineer, who must have a thorough understanding of the practical requirements of the system to be established. A radio system patterned along the lines of police and highway radio operations, where the principal need is contact from cars to fixed central stations, is usually inadequate for the business of fire detection and suppression communication. Such systems, particularly in rugged country, will usually fail to provide direct fire line communication and are relatively expensive to install and maintain. In determining the extent and type of radio network required the following points should be considered:

(*a*) Essential service requirements.

(*b*) Type and number of sets required.

(*c*) The services of a skilled radio technician are essential for satisfactory operation of the system.

(*d*) Equipment, maintenance, and repair costs are usually high.

(*e*) The average life of a radio set is short.

(*f*) Present model sets soon become obsolete.

(*g*) Determination of type and extent of possible interference by other systems.

When requested by the States, the Forest Service will furnish technical assistance in planning and developing fire protection radio communication systems.

FREQUENCIES AND TRANSMISSION

Radio communication in forestry, although requiring over-all coordination, can be roughly broken down into two general classes of service and equipment types: portable and fixed. At the present time there are three distinct bands of frequencies in which forestry radio may be operated: MF (medium frequency, 300 to 3000 kc); HF (high frequency, 3000 to 30,000 kc); and VHF (very high frequency, 30,000 to 300,000 kc). These frequency bands are not necessarily related to the two classes of service, fixed and portable, but can be applied to either when appropriate equipment is selected.

The present trend in choice of frequencies is toward more intensive use of the VHF region where static and fading problems are minimized and where an efficient antenna can become a part of a portable radiophone, instead of 150 feet of antenna wire to be supported independently of the set, as in the case of HF equipment.

VHF radio transmission range is limited primarily by the topographic features in the transmission path. VHF rarely can be expected to provide communication from the bottom of one deep canyon, over a thousand-foot or higher intervening ridge, and down into another canyon, even though the horizontal distance between stations may be but one or two miles. However, if one of the terminal stations is on an elevated point, the ability to transmit over ridges and into non-visible areas is often amazing. On the whole, VHF may be expected to give adequate coverage in extremely rough country if care is exercised in selecting the fixed stations that are to serve as contact points for portable and mobile units.

Where a VHF radio network with automatic radio repeaters to reach central administrative points is not in existence, service-of-supply communication from large fires can best be handled over relatively long distances by the use of HF radio equipment.

Throughout the summer months severe static conditions and fading of signals may be expected on these frequencies. In addition, the transmission range on HF is extremely variable, both seasonally and by time of day, and even when communication over a distance of 5 miles may be difficult or even impossible at a given time, an extremely strong signal may be transmitted over distances of 75 to 100 miles or more. This characteristic is unfortunate in that serious inter-forest or inter-regional interference may be produced.

TYPES OF EQUIPMENT

Following are descriptions of types of equipment now used by the Forest Service and of developments under way:

MF—HF Equipment

Type SPF, Model AF.—A portable or semi-portable unit (depending on type of batteries used), suitable for either fire line or lookout applications. (Fig. D–1.)

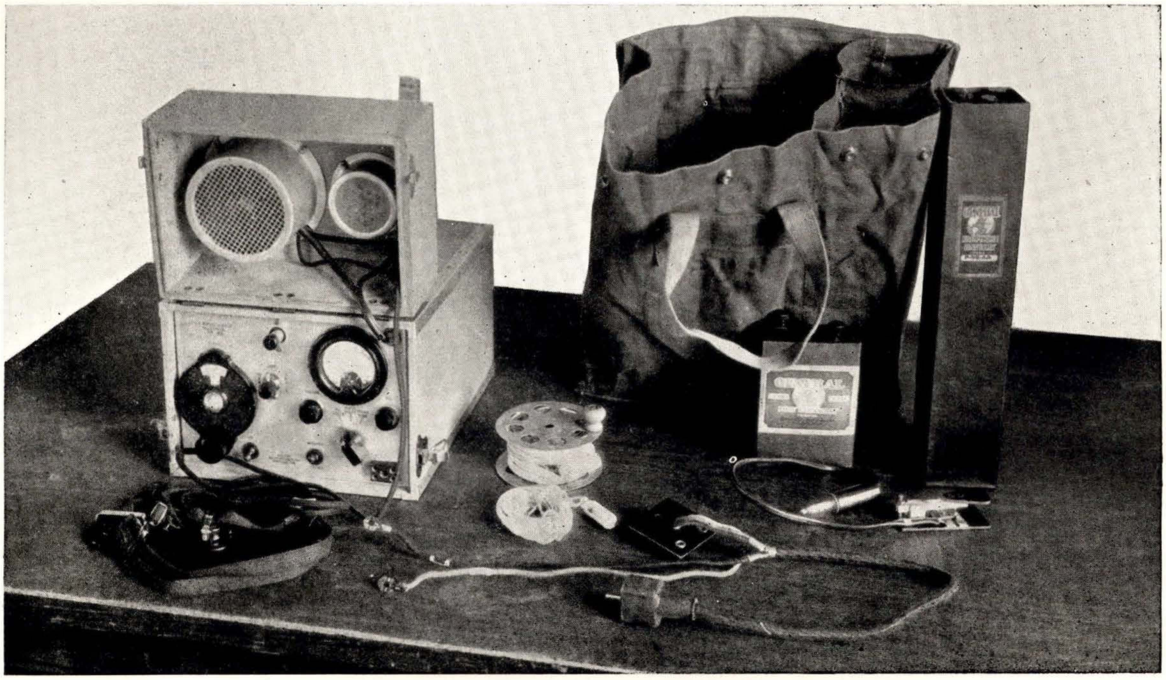


FIGURE D–1.— Type SPF radiophone, with container and portable batteries.

In portable form, the set complete with light-duty batteries in canvas carrying case weighs approximately 20 pounds. The portable antenna is a single wire approximately 100 feet in length, which must be supported at the free end at a height of 15 feet (preferably higher) and slope to the radiophone at or near ground level.

For semi-fixed service, such as at lookouts, the set is powered with heavy duty batteries. Set and heavy duty batteries, together with all accessories for portable operation, are available in a wood kit box suitable for transportation and storage of the complete radiophone.

The antenna for fixed installation is approximately 150 feet long, must be supported at both ends at a height of 20 feet or more, and has a separate lead-in wire. The average communication range is stated as 20 miles. However, the actual range is dependent upon many variables (see discussion under "Frequencies and Transmission").

Condensed Specifications

Power source:	Dry batteries.
Receiver:	Frequency range—2900 to 3450 kc (lower frequency ranges available down to 2000 kc with sacrifice of high frequency range). Circuit — 5 tube superheterodyne having a minimum usable signal sensitivity of approximately 1 microvolt. Output—loud-speaker or headphones.
Transmitter:	Frequency range—single frequency at any point within the range of 2900 to 3450 kc. Circuit—crystal controlled oscillator modulated output amplifier. Output—approximately 2 watts.
Weight:	Portable form, approximately 20 pounds. With kit box and heavy duty batteries, approximately 60 pounds.

Type M, Model D.—A fixed station transmitter and receiver operating on 120 volt, 60 cycle, alternating current only (fig. D-2).

The type M radiophone is intended for use as the central contact station for SPF radiophones in the field. The receiver in this unit is more sensitive and the transmitter more powerful than those in the SPF radiophone, primarily for the purpose of offsetting the less favorable conditions of installation and transmission and reception at the portable stations. The antenna required is approximately 150 feet in length and should be supported as high as possible (40 feet or higher is desirable).

Condensed Specifications

Power source:	110-120 V, 60 cycle, A.C. (commercial power).
Receiver:	Frequency range—2900 to 3450 kc (lower frequency ranges available down to 2000 kc with sacrifice of high frequency range). Circuit—7 tube superheterodyne having a minimum usable signal sensitivity of less than 1 microvolt. Output—loud-speaker or headphones.
Transmitter:	Frequency—single frequency at any point within the range of 2900 to 3450 kc. Circuit—crystal controlled oscilator modulated output amplifier. Power output—approximately 12 watts.
Weight:	Approximately 90 pounds.

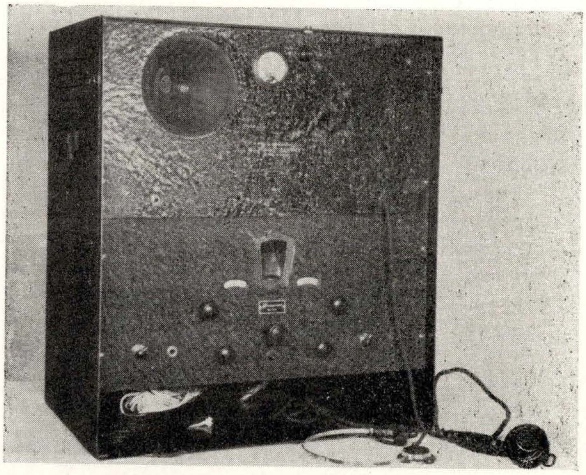


FIGURE D-2.—Type M radiophone.

VHF EQUIPMENT

Types SX, T, U, KU-R, KU-T, and KU-T2 are now current.

Portable Equipment.—The types SX and T, portable and semi-portable, respectively, are being completely redesigned to eliminate certain features which have proved objectionable in these models and to increase the effective communication range and simplify operation. It is expected that the portable will take the general form of the military handy-talkie, i.e., completely self-contained.

Automobile Equipment.—Type KU-R is a mobile type receiver which has been available with manual tuning only over the range of 30-40 megacycles. This equipment is now being modified so that either the present arrangement or one or more fixed frequencies may be used. The fixed frequency arrangement is preferred because of elimination of manual controls and over-all improved performance.

Types KU-T and KU-T2, single and double frequency mobile transmitters, respectively, are also being modernized. The new KU-T will have a power rating of 25 watts, and the KU-T2 will develop about 6 watts output.

Aircraft Equipment.—In addition to the above, work is current on a multiple frequency (both HF and VHF in the same unit) aircraft transmitter and receiver. This set will provide for remote control operation of 3 VHF channels and 2 HF channels. Inter-communication between pilot and passengers or dropping crews is also being provided.

Repeaters (relays) and Lookout Equipment.—Radio repeaters or relays have been operated experimentally by the Forest Service for several years and much progress has been made toward development of satisfactory equipment. The general plan contemplates a series of basic units: Transmitter, receiver, automatic control panel, telephone line to radio circuits, and remote control device. From such basic units a simple two-way lookout radiophone can be assembled or, by addition of the necessary units, such a combination can be arranged to serve as an automatic relay or repeater.

Reliability is the foremost consideration and, accordingly, the unit will be somewhat larger than previous units intended for lookout service. In instances where the lookout station is a 7x7 foot cab, the radio equipment must be located in a small shelter at the base of the tower and controlled either from the tower cab or a ground house. Storage batteries, to be charged by small gasoline driven generators, will be required.

This equipment will not be released for general use until tests have proved that it will give reliable service. It is expected that a limited number of trial units will be available for general distribution by spring, 1947.

One of the important advantages of such equipment will be the elimination of back-country telephone lines which are maintained only for seasonal use.

Fixed Stations.—The type U radiophone is designed for operation on 110-120 volts a.c. (commercial power) only, and is similar in physical form to the type M radiophone in the HF field.

The receiver in this unit is tunable over the range of 31-39 megacycles and is also provided with "spot-frequency" control to allow permanent "stand-by" on any one of three fixed frequencies. The purpose of this "spot-frequency" control is to prevent drifting of the receiver from the desired "stand-by" frequency, thus assuring proper tuning at all times.

The transmitter is capable of operation on either of two predetermined frequencies merely by manipulation of a single control knob, and has a power output of approximately 10 watts.

Where single frequency operation is possible, or where the terminal station is dependent solely upon a repeater or relay station for all incoming and outgoing traffic, it is expected that the fixed station equipment, such as is currently being designed for lookouts, will replace the type U radiophone at forest supervisors' and rangers' offices.

Telephone Instruments

Many different types of telephone instruments are used by the Forest Service. The Forest Service Tele-

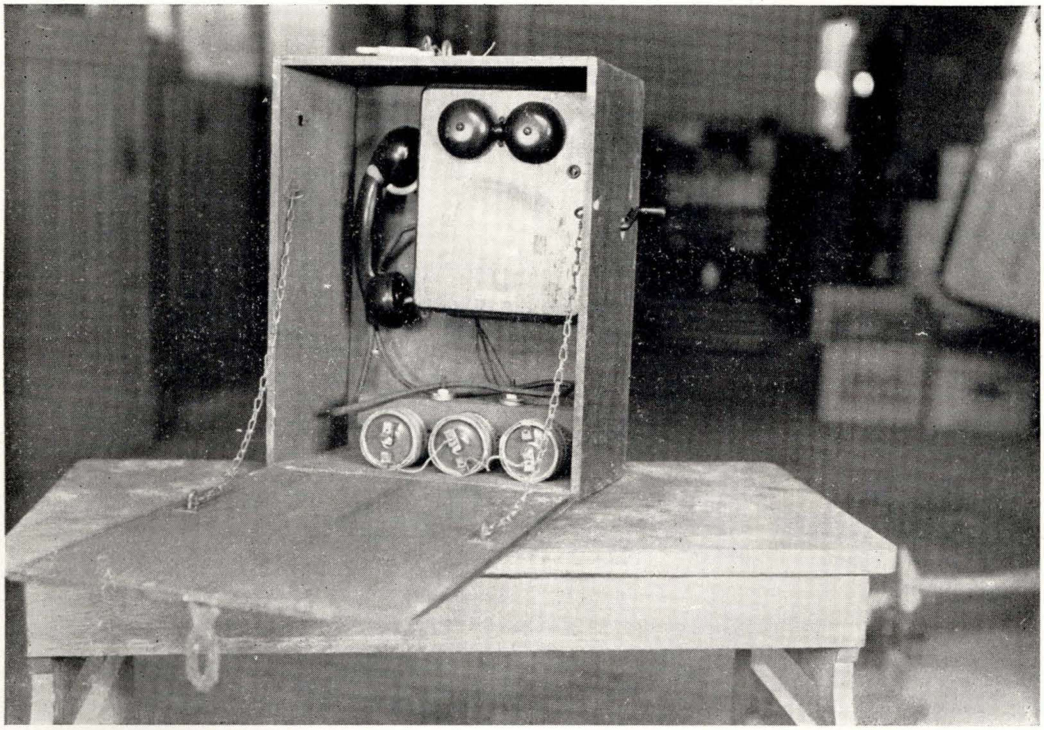


FIGURE D-3.—Emergency telephone outfit.

phone Handbook provides complete and detailed information regarding both telephone instruments and telephone lines; therefore, the data given on this sort of equipment are confined to four types of instruments commonly used in connection with fire control work.

Outfit, Telephone, Emergency.—The emergency telephone outfit shown in figure D-3, or a similar outfit, is used in certain localities for connecting five camps with permanent telephone lines. The outfit illustrated consists of a standard grabaphone, 3 batteries, installed, a lightning arrester, a short copper or copperweld ground rod, about 30 feet of emergency wire, a screwdriver, pliers, and a roll of friction tape, all enclosed in a plywood box, with provision for attaching the telephone crank from the outside. A take-up reel and spools of emergency wire, as needed, are packed in a separate box, or otherwise assembled for transportation.

Telephone, Portable, Army Model EE8B.—A compact, light-weight magneto telephone, contained in a weather-proof, treated-fabric carrying case. It employs a standard hand-set type receiver-transmitter unit, a special light-weight, high output magneto, and standard flashlight batteries. Weight with batteries, 9½ pounds. Approximate cost, $40.

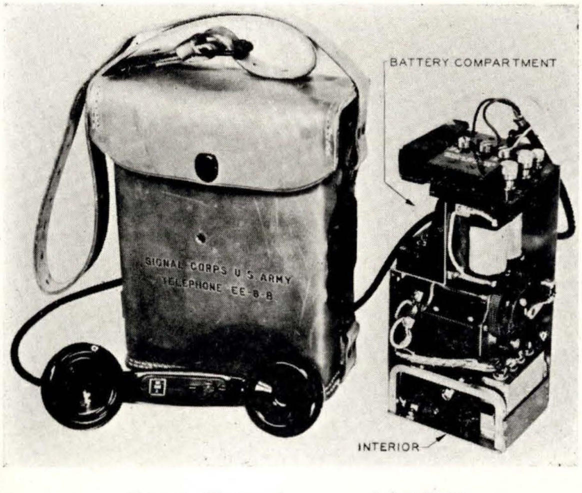


FIGURE D-4.—Army model EE8B.

Wire, Emergency, Single-Conductor.—A strong but lightweight, rubber-covered telephone wire, the conductor consisting of 10 strands of No. 29 a.w.g., hard-drawn copper wire, twisted with approximately a 1½-inch lay. The wire is put on steel spools in lengths of approximately ½ mile, weighing about 17 pounds each. The insulation used is sufficient to withstand 4,000 volts after 1 hour's submersion in water. This feature makes the wire particularly adaptable to emergency use, where the telephone line is strung out through the woods, either hung up in bushes and trees or laid directly upon the ground. A spool of single-conductor wire is shown on the take-up reel illustrated (fig. D-5). Cost, $26 per mile.

Wire, Emergency, Double-Conductor. — This wire consists of two conductors twisted together with approximately four twists per foot of length. Each conductor is similar in construction to the single-conductor wire described. Double-conductor wire is put up in ¼-mile lengths on steel spools, each weighing approximately 18 pounds. Cost, $55 per mile.

Reel, Wire Take-up. — The emergency wire take-up reel is a simple device, consisting of a galvanized sheet-metal frame with ¼-inch steel rod spool holder in which a lightweight crank and spool shaft are installed for rewinding wire (fig. D-5). When stringing out emergency wire, the outfit is carried in the hand or on the back. When taking up wire, the reel is strapped to the operator's chest so that the crank can be operated. The entire reel folds into a very small, lightweight package. Approximate cost, $1.40.

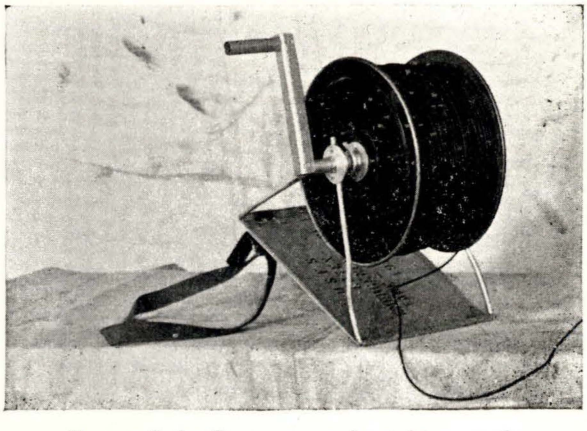


FIGURE D-5.—Emergency wire take-up reel.

SECTION E

PHOTOGRAPHIC EQUIPMENT

Cabinet, Aerial Photographic Developing.— Region 1 has developed a portable cabinet (fig. E–1) for developing and printing pictures while in flight. With this equipment, an aerial scout can develop and print aerial pictures in from 13 to 20 minutes and drop them, in a tube with streamer attached, to the fire camp.

For best results, two types of aerial fire pictures are ordinarily taken: General pictures from various angles at distances of 1 to 2 miles, and closer pictures of the fire edge to show types of fuels, hot spots, progress of the fire, etc. With the developing cabinet, the information disclosed by the pictures can be made available to the fire boss quickly.

The cabinet is modeled after one produced by the Fairchild Flight Laboratory, but it was necessary to provide for drying and dropping. Outside dimensions are 19 by 14 by 22 inches. Weight of cabinet alone is 46 pounds, but the complete outfit, including battery, stand, solution bottles, and equipment box, is 150 pounds.

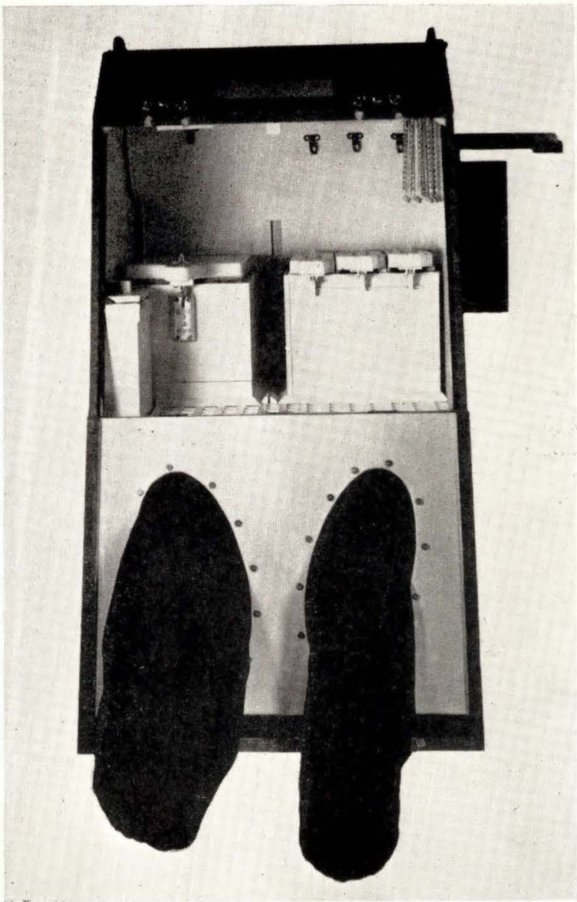


FIGURE E–1.— Aerial photographic developing cabinet.

The model required 25 man-days to construct, but a similar cabinet could be constructed in much less time now that a satisfactory design has been developed. Materials cost approximately $50.

Transit, Photo-Recording, Osborne.—This instrument consists of a special camera, with alidade, a tripod head, and a heavy tripod. The camera lens rotates through an arc of 126°, the rotation being controlled by clockwork and a fan. Interior scales register level line markers and azimuth and vertical angles scales on the film. A Smith solar attachment may be mounted on the camera if desired. The tripod head is equipped with leveling screws and a full azimuth circle, with vernier.

In operation, the instrument is set up, leveled, and oriented in the same manner as a transit. The negative resulting from each exposure covers an arc of 126° and is graduated precisely and numbered in azimuth along its top margin. The level points and vertical angle scales register at the sides. When a level line is scratched on the negative, so that it will show on all prints, the vertical angle of any point on the photograph may be read by means of a vertical-angle scale printed on paper. The name of the point from which the exposure was made, and other data may be lettered on the negative, if desired, so they will show on all prints.

A special case, with overcoat box, is needed for the camera, as for a transit, with separate shipping boxes for the tripod and tripod head. The camera in its case weighs approximately 40 pounds. The cost of the complete outfit, including cases but without solar, is estimated at $1,200. The instrument, assembled for use, with Smith solar attachment, alidade, spirit level, and fan housing in place, is illustrated in figure E–2. A typical photograph taken with the instrument is reproduced in figure E–3.

The camera requires film made up according to specifications on file with Eastman Kodak Company. The size is 5-15/16 inches by 100 inches, six exposures per roll. Rolls must have extra long leaders and tailpieces and special spacing of numerals on the paper backing. Orders should state that film is for use with the Osborne photo-recording transit.

Photographs taken with this instrument, accurately leveled and oriented on lookout points, are used for mapping seen areas and by members of the protective organization in connection with location of fires and dispatching. A complete set of photographs (three to a set) is taken from each lookout station and prints are furnished to the district ranger or dispatcher, the lookout, and smoke-chasers needing them. With a movable vertical-angle scale the exact spot on which the lookout has taken horizontal and vertical angles with the fire finder can be determined, and all parties concerned can discuss the location by telephone or radio with the photographs before them. Since the exposures will have been made when visibility was good the photographs will be particularly useful when fires are discovered at night or when visibility is decreased by smoke or fog. The prints are ideal for assisting new lookouts to learn their country, particularly if the names of prominent peaks, ridges, and streams have been lettered on the negatives or the prints. Seen-area maps can be prepared from the photographs at any convenient time as readily as they could be prepared from topographic maps. The interior scales and adjustments are accurate to within 2 minutes of arc. Comparisons of horizontal and vertical angles obtained from photographs with transit readings on the same objects have shown maximum discrepancies of 3 minutes.

Photographs made with this instrument may also be used for making map corrections, checking fire-finder orientation, illustrating special hazards, and to obtain information for grazing studies and timber, road, and other surveys.

In addition to placing orders for this instrument through Region 6, users may obtain from that region detailed notes on use and adjustment of the instrument, prepared by the designer.

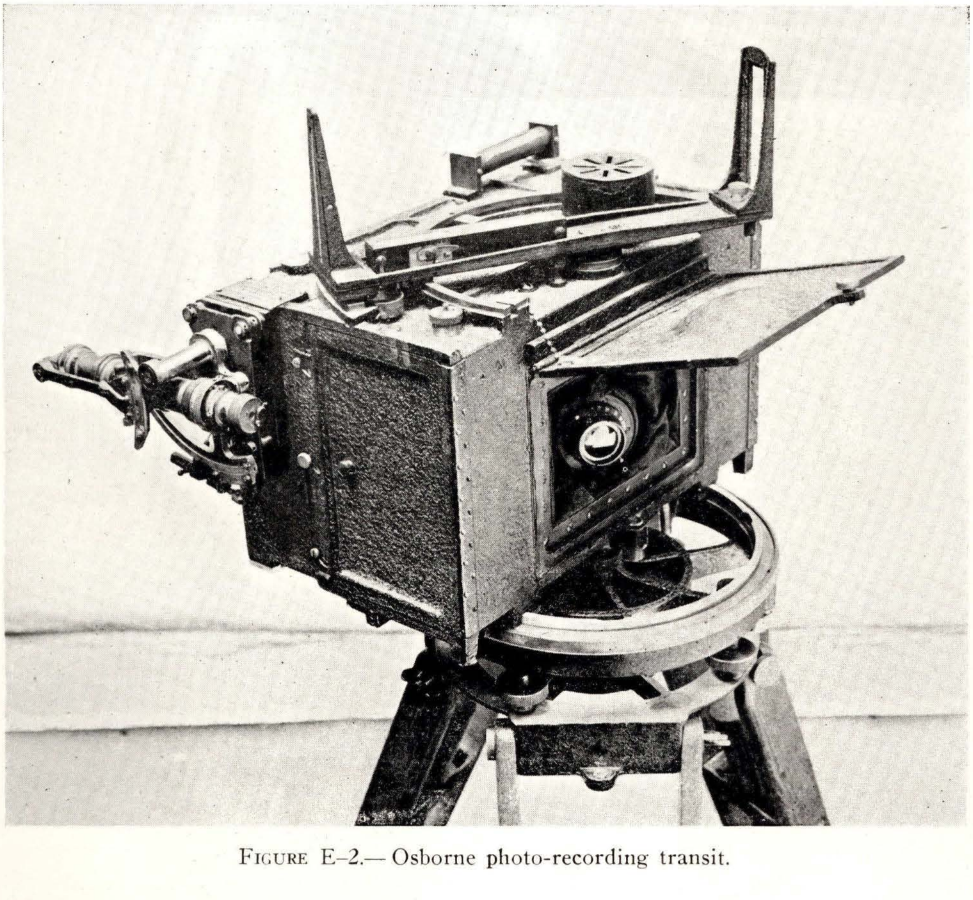


FIGURE E-2.— Osborne photo-recording transit.

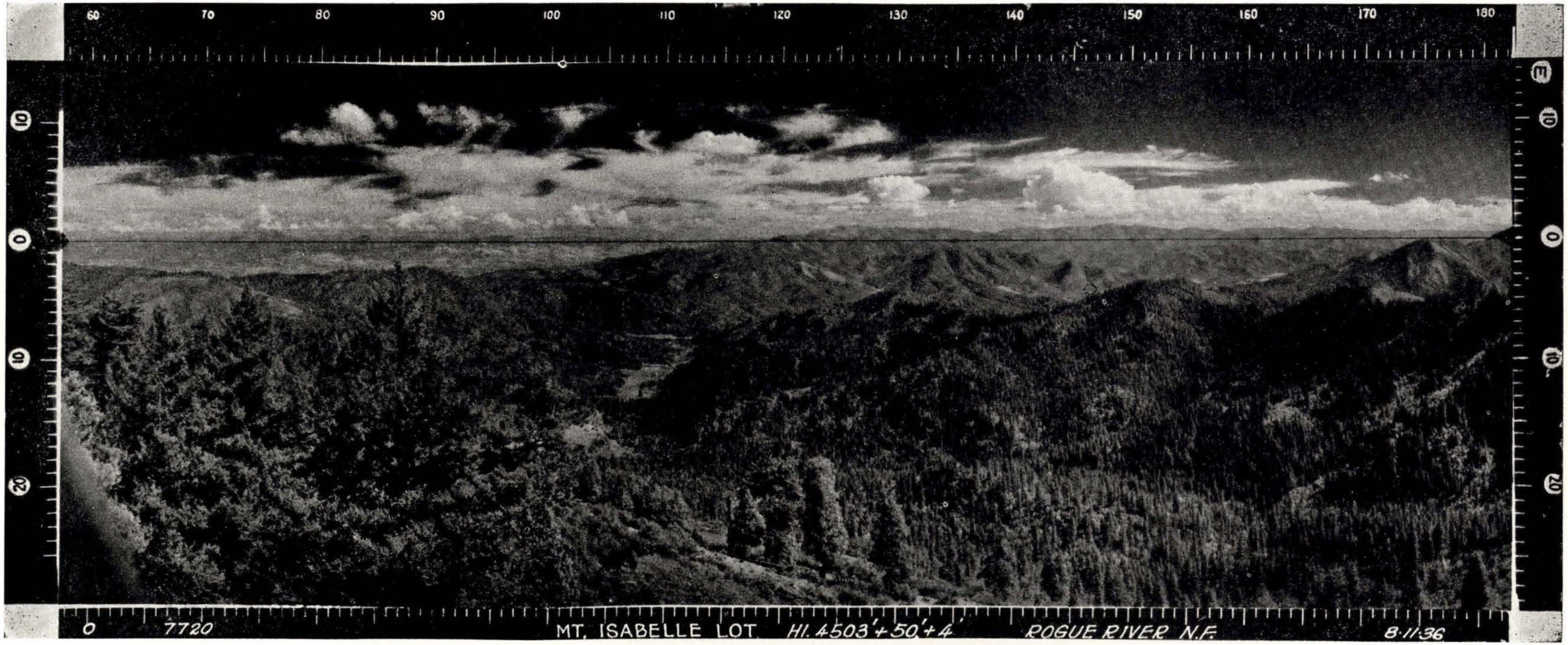

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FIGURE E-3.— Photo taken with Osborne photo-recording transit (reduced almost one half).

SECTION F

TRANSPORTATION EQUIPMENT, VEHICULAR

Trailers

The types and designs of trailers used in connection with fire control work are so many and varied that it would be impracticable to enumerate all of them in the handbook and include detailed specifications in the master file. Accordingly, only a few typical units have been selected from the many designs for which data have been submitted.

Detailed specifications for the trailers are not included, principally because of the changes frequently necessary and local conditions which may require alternate design. Additional information, however, is available in most instances in the form of specifications and drawings. These can be obtained from the sources indicated in the Specification Index, in accordance with the procedure outlined in the Foreword.

Trailer, One-Horse (Region 5).—The trailer shown in figure F–1 was designed in Region 5 for comfortable and safe transportation of horses in areas where extreme variations in climate occur in comparatively short distances. Under such conditions windbreak features are important.

Instead of conventional springs, shock insulator rubber is used between the axle and frame. This absorbs road shocks without causing the roll and sway that may occur where conventional springs are used.

The trailer body is constructed of aluminum alloy, and has a saddle compartment and an escape door. A window at the front does not appear in the illustration. Fenders, taillight, and wheels are standard automobile type. Brakes are vacuum type. A spare tire is carried in front of the saddle compartment and above the tongue. The floor of the horse compartment is covered with wire insert belt lagging.

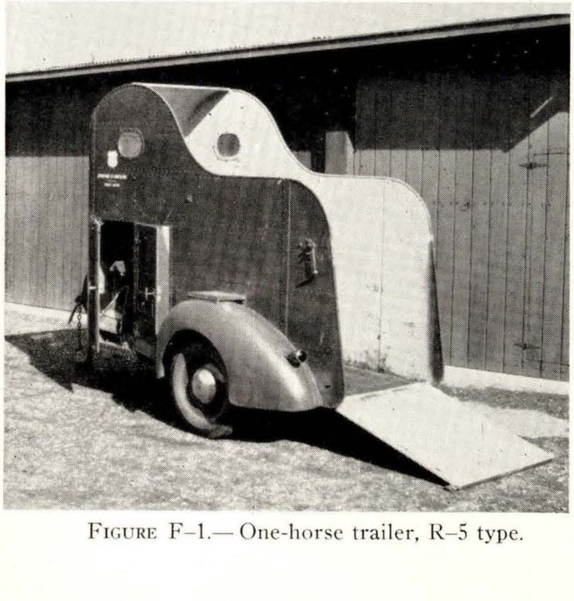


FIGURE F–1.— One-horse trailer, R–5 type.

Dimensions

Width of body	3 feet
Length of body (horse compartment)	6 feet, 6 inches
Length over-all (without tongue)	9 feet
Length of tongue (bend of ball hitch)	2 feet, 7 inches
Height of horse compartment from floor	7 feet, 1 inch
Height over-all	8 feet
Ground clearance	11 inches
Axle location (from front of body)	5 feet, 9 inches
Size of tires	6.50 by 16 inches
Weight of trailer	800 pounds

Cost of this trailer is approximately $750.

Trailer, One-Horse (Region 3).—This trailer (figure F–2) was designed in Region 3, where this type has given good service for 8 years. The sides are constructed of 1-inch pine, and the breastboard, tailgate, and floor of 2-inch pine. The body is bolted to an angle iron frame, 3 by 3 by 5/16 inches, laid into oak sills, 3 by 6 inches, which are bolted to a passenger car front axle assembly. Side cleats are channel iron, 2 by ¾ inches, and front corners are angle iron, 2 by 2 by ⅛ inches. The drawbar is 25-pound steel rail, 2¾ by 2½ inches, bent around and bolted to the axle. Vertical cleats on the tailgate, which hinges at the bottom to act as a loading ramp, are 8-pound steel rail, 1½ by 1½ inches. Provision for carrying a spare wheel and tire may be made at the side of the trailer.

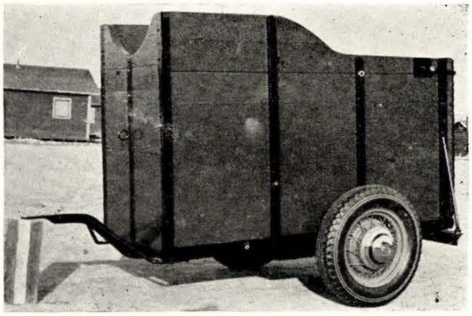


FIGURE F–2.— One-horse trailer, R–3 type.

This trailer has no springs, and the balance is very good. It can be pulled by a half-ton pick-up truck up a 10 percent grade, carrying an 1,100-pound horse.

Dimensions

Bed, inside, length	6 feet, 4 inches
width	2 feet, 9 inches
Sidewalls, height, at front	4 feet, 4 inches
at rear	3 feet, 6 inches
Over-all, length	8 feet, 6 inches
width	5 feet, 4 inches
height	5 feet, 8 inches
Clearance	9 to 10½ inches
Tires	5.50 by 17 inches
Weight	800 pounds

Approximate cost, $400.

Trailer, One- and Two-Horse. — This trailer (figure F–3) will accommodate two average-size horses without difficulty, yet it can be used to transport a single animal without roping or installing a partition. The side panels are constructed of ½-inch waterproof plywood, strengthened with angle iron braces, 2 by 4 inches. The floor and rear door are of planks, 2 by 6 inches, bolted together, with sufficient cross cleats to provide a firm footing for horses. A sheet metal manger overhangs at the front and the rear door lets down to form a loading ramp.

The trailer body is mounted on a full channel iron frame. The axle is a 2-inch solid steel rod, enclosed in ¼-inch seamless tubing, which is welded to the frame. The axle stubs are made of steel, to fit the particular wheel used. An extension for the exhaust pipe of the towing vehicle is welded to the undercarriage of the trailer, and a piece of 1¾-inch flexible tubing is provided for the connection. A taillight is installed on each side of the trailer at the rear, and a reflector button on the left side. A spare wheel is carried under the manger.

Trailer, Tilt-Bed, Single Tandem Wheel.—This trailer (figure F–4) was designed in Region 9 for hauling heavy tractor-plow units over low service truck trails, sand rut trails, and firebreaks. The tilting bed facilitates loading and unloading. The large single wheel tandem assembly was selected as the easiest to pull under adverse conditions.

The trailer is designed for use with a 2½-ton truck, equipped with a fifth wheel. A hydraulic jack is used to operate the tilt bed, which measures 22 by 8 feet. The over-all length of truck and trailer is approximately 39 feet. The trailer weighs 5 tons and has a maximum capacity of 12 tons. Its cost is approximately $2,200.

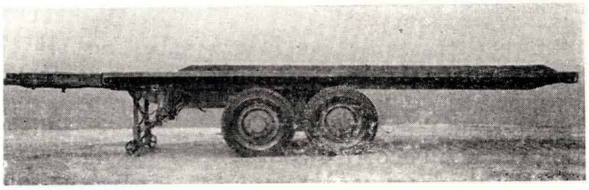


Figure F–4.— Single tandem wheel, tilt-bed trailer.

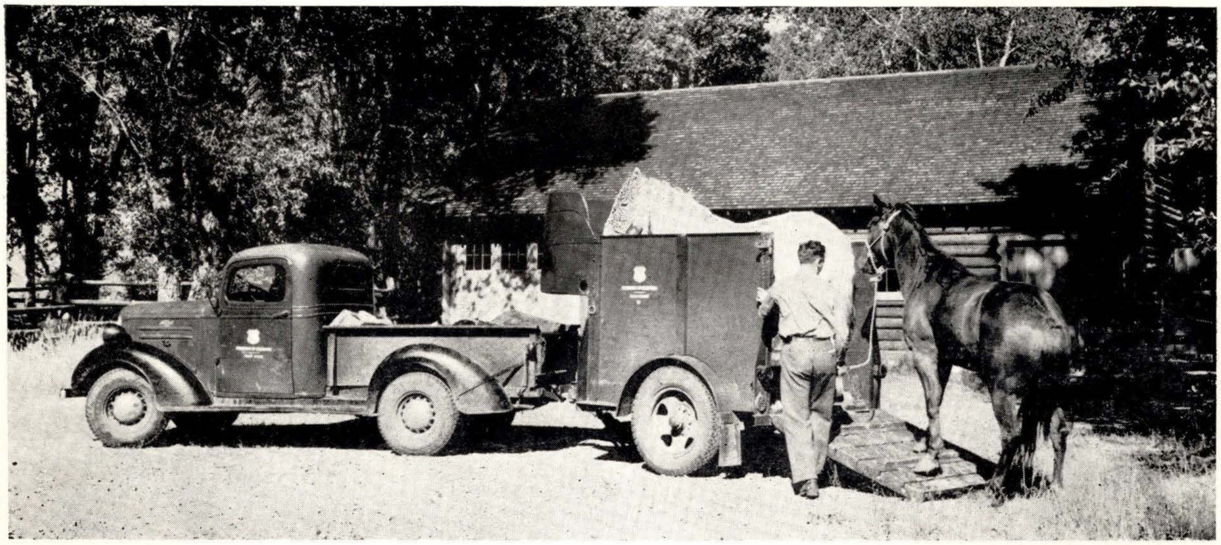


Figure F–3.— One- and two-horse trailer.

This trailer can be towed by any passenger car or truck equipped with a ball to fit the socket of an Atwood No. 705 lever hitch. The weight is such that the towing vehicle should have a four-speed transmission.

Dimensions

Length, inside	6 feet
Width, inside	4 feet, 6 inches
Height, inside, behind manger	4 feet, 8½ inches
Tires	7 by 20 inches
Weight	1500 pounds

The cost is approximately $700.

Trailer, Tilt-Bed, 5-Ton.—The trailer illustrated in figure F–5 was designed by the Wisconsin Conservation Department, which has used more than 70 tilt-bed trailers of from 3½- to 10-ton capacity since 1938. Its construction is simple and sturdy; its outstanding features are rapid loading and unloading and adaptability to transportation problems on the highway and the fire line.

A standard 1½-ton truck with the lowest gear ratios obtainable is used as the towing unit. The usual load is a crawler-type tractor of 20- to 32-horsepower, weighing from 3½ to 4 tons, and a

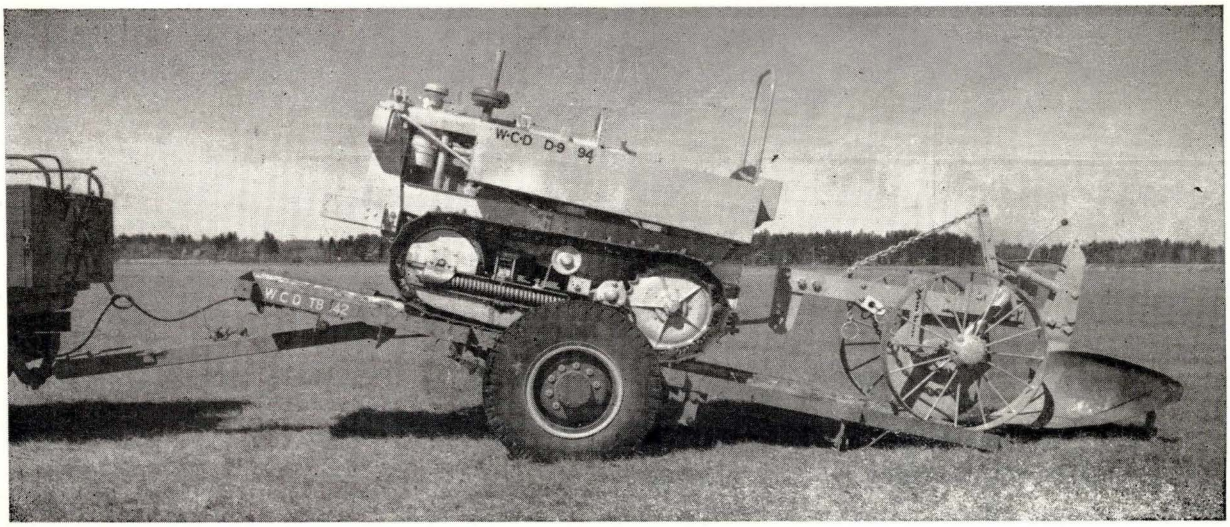


FIGURE F–5.— 5-ton tilt-bed trailer, in loading position.

fireplow, weighing about 1 ton. The load is carried well forward, from ¼ to ⅓ being transmitted through the tongue to the towing truck. When a mudhole or steep grade makes it necessary, the tractor can be unloaded quickly and used to extricate the truck, driven around the obstacle, and reloaded.

The trailer bed is 5 by 16 feet. Three-inch planks are laid lengthwise inside the frame on four 4-inch angle-iron cross members, and two timbers, 8 by 8 inches, provide lengthwise support and prevent the load from slipping while in transit. The trailer is equipped with 14-ply tires, 11 by 20 inches, electric brakes with controls in the towing truck cab, and a 2-inch ball hitch, which is standard for all trucks and tractors used by the Department. Empty weight is approximately 3,200 pounds .

The trailer bed is not balanced on the axle, being about 2 feet longer at the rear. When released, it assumes a loading position, and it tilts forward and is locked as the tractor, in loading, goes over the center. The trailer is slightly front-heavy because of the heavy tongue.

Trailer, General Purpose.—This trailer (fig. F–6) was designed at the Michigan Forest Fire Experiment Station primarily for transportation of hand equipment behind any car or truck, and the safe, orderly storage of such equipment when not in use. In the development multiple use was stressed. Two models were designed especially for 10-man and 20-man equipment units, and the same type of bed is used for a portable pumper and all accessories.

The trailer has a light tubular steel frame on which a light bed is mounted. It is equipped with a standard trailer coupling and all cars and trucks that might be used to tow it are equipped with the mating half of the coupling.

Specifications

		10-man unit	*20-man unit*
Over-all length	inches	104	130
Length of Bed	"	73	96
Length inside box	"	55	78
Width of box	"	43	43
Depth of box	"	20	20
Carrying capacity	pounds	2,000	2,000
Approximate weight	"	300	375
Approximate cost of materials		$115	$115

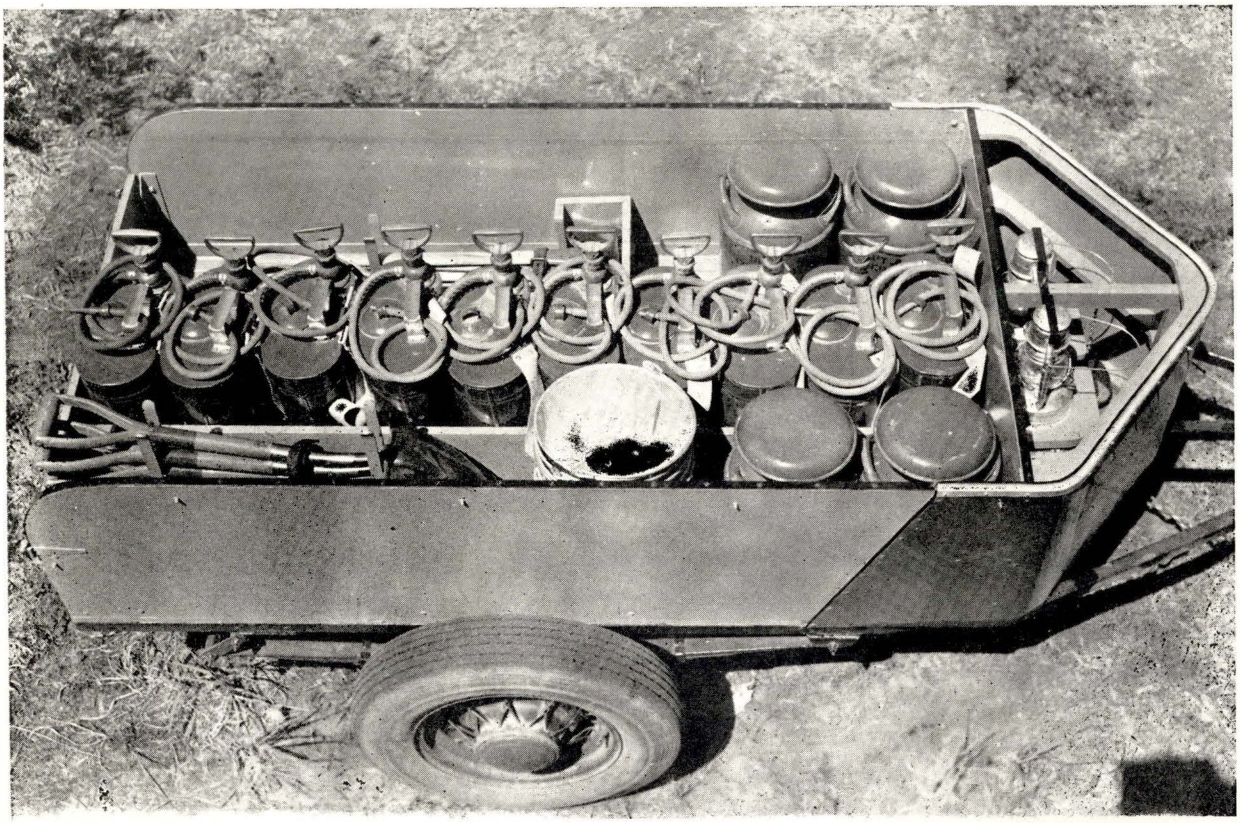


FIGURE F–6.— General purpose trailer, with 20-man fire control outfit. Michigan Department of Conservation.

Truck Bed

Truck Bed for Tractor-Plow Outfit.—A very satisfactory bed for a standard 1½-ton long-wheel-base truck to transport an H. G. Cletrac Tractor and Ranger's Pal plow, with certain other fire fighting equipment, has been designed in Region 8 (figure F–7). The regular truck bed was rebuilt to provide a flat deck 7 feet, 9 inches long, and a sloping deck 7 feet, 2 inches long, with a fall of 16 inches. This fall leaves ample clearance at the rear and facilitates loading. The truck bed is 5 feet, 2 inches wide. The angle iron legs shown at the rear of the sloping deck prevent unbalance of the truck when it is being loaded. When not in use, they are locked against the truck bed. Two

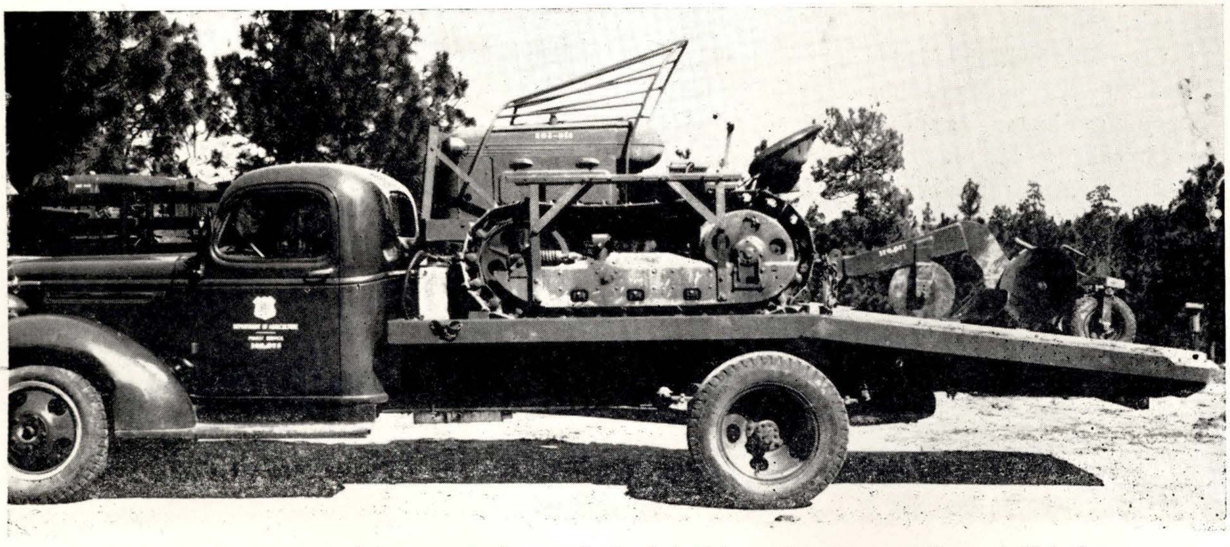


FIGURE F–7.— Truck bed for tractor-plow outfit, loaded with small tractor and Ranger's Pal plow.

sets of loading planks, 7 feet, 2 inches long are provided.

A 6-man fire tool box is carried underneath the tractor, with a back-pack can and pump mounted on each side of the box against the cab. Stop blocks, attached to the truck bed, prevent the tractor from crushing the back-pack cans.

Trucks with special beds, as described, are used in ranger districts where fire occurrence requires Ranger's Pal plows with suppression crews for initial attack. Travel time with the outfit is comparable to that with a pick-up truck, loaded with tools, water, and men. While the truck bed was designed for a particular tractor-plow outfit, a similar design could be used for other outfits which are too long for the standard truck bed. However, some types of tractors would not have sufficient clearance for a tool box underneath.

Carrier

Carrier, Crew, Slip-On.—The carrier illustrated in figures F–8 and F–9 was designed in Region 6 for transporting a fire-suppression crew of 16 men (1 in cab with driver) and their tools and packs, in a 1½-ton standard wheelbase truck. It consists of 2 sections which may be loaded separately. Each section has 3 seats, each accommodating 2 men, and a box for 8 packs. There are 3 folding jump seats, so that the 2 sections will seat 15 men. Space for tools is provided under the boxes. Hooks at the outer edges of the boxes hold the sections in place, and a spreader (not illustrated) is fastened across the aisle at the front.

The carrier complete weighs about 500 pounds and can be constructed for about $300. Similar carriers have been used in Region 6 to transport crews up to 300 miles, with no complaints of discomfort. The carrier can be used to move the crews not only between their home camps and the fire camp, but also between the fire camp and the job.

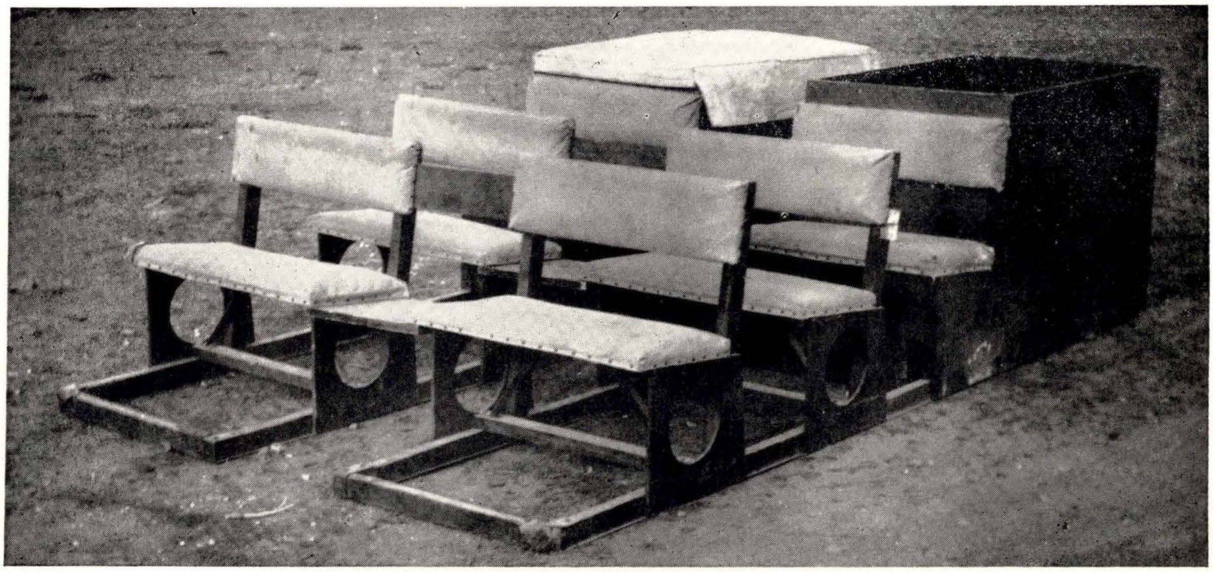


Figure F–8.— Slip-on fire crew carrier ready for placement on truck.

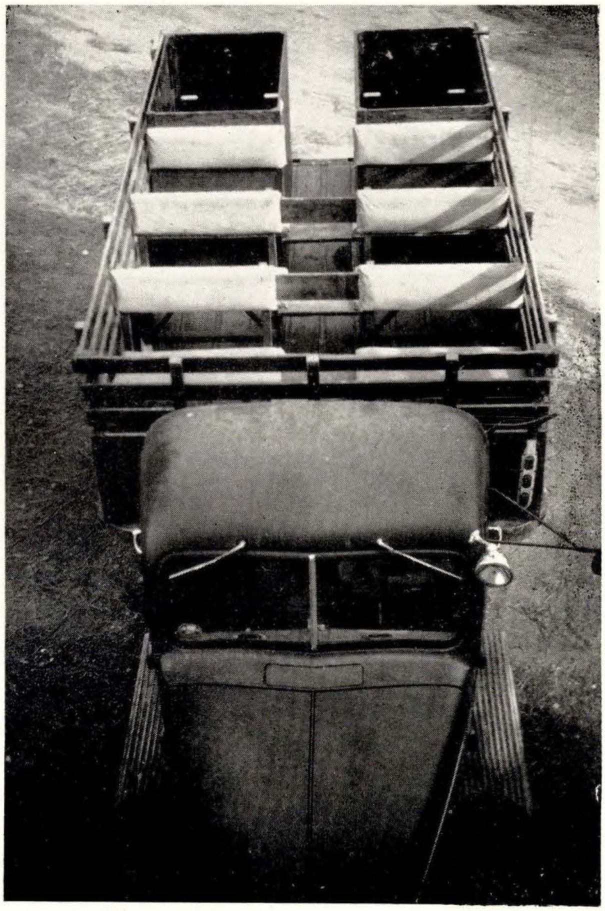


Figure F–9.— Slip-on fire crew carrier in place on 1½-ton truck.

SECTION G

WATER-CARRYING EQUIPMENT

Bucket, Canvas.—(Refer to sec. N, camp equipment, miscellaneous items, and fig. N-18.)

Bags, Water, 2- and 5-Gallon.—The standard water bags for Forest Service use are manufactured from first-class flax duck and are available in two sizes (fig. G-1, 2, and 3). Both the 2- and 5-gallon sizes are provided with rope handles so that the bag hangs the long way up and down. Each bag has a suitable metal filler vent and cork. Dimensions of the 2-gallon bag are approximately 12 by 16 inches, and the 5-gallon bag 16 by 24 inches. The latter is often used to carry water on a stock saddle. Cost, 2-gallon bag, 75 cents; 5-gallon bag, $1.40.

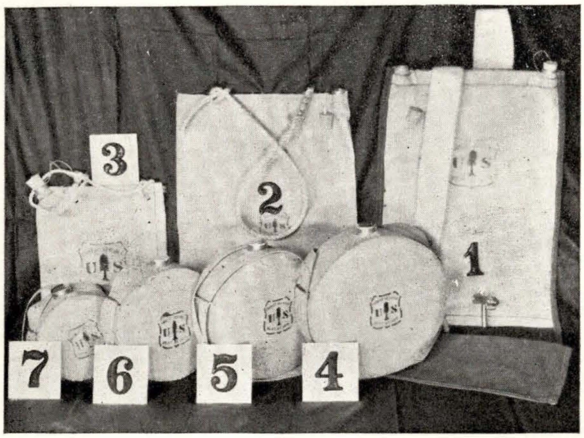


FIGURE G-1.—1, Five-gallon man-pack water bag; 2, 5-gallon water bag; 3, 2-gallon water bag; 4, 8-quart canteen; 5, 4-quart canteen; 6, 2-quart canteen; 7, 1-quart canteen.

Canteens, 1-, 2-, 4-, and 8-Quart.—The standard canteen is the round-type galvanized-iron canteen made either in 1-, 2-, 4-, or 8-quart size as required. (Figure G-1, 4, 5, 6, 7). Each canteen is covered with blanket material and recovered with khaki duck. It is provided with a shoulder or carrying strap which is securely fastened to the canteen by metal loops. The 4-quart size canteen is 9¼ inches in diameter by 4⅛ inches thick. The 1-, 2- and 8-quart sizes are proportional according to capacity. The filler vent in all four sizes is the same so that canteen tops and gaskets are interchangeable. Cost: 1-quart, 55 cents; 2-quart, $1.15; 4-quart, $1.50; 6-quart, $2.

Gasket, Canteen Top.—The standard type of canteen-top gasket best adapted to canteens which are used to carry drinking water, etc., can be procured upon the following specification:

Specification.—Gaskets to consist of a semi-soft fibre composition in disk form, 1½ inches in diameter by 1/16 inch thick. Gasket to be thoroughly waterproof and of a composition which will not peel, wrinkle, or impart injurious or distasteful properties to drinking water.

Bag, Water, Man-pack, 5-Gallon.—The 5-gallon, man-pack water bag is a desirable piece of equipment where it is necessary to pack water for a considerable distance, either for drinking purposes or fire-suppression work (fig. G-1, 1). The bag part of the man-pack, made of first-class flax duck, is approximately 16 by 24 inches. This bag is attached at the sides and top to a piece of thoroughly waterproofed canvas 16 by 40 inches, to which the web shoulder straps for carrying the bag are securely fastened. The bag is provided with a compression bib outlet having a ½-inch standard hose nipple 2 inches in length, suitable for the attachment of a hand-pump hose for suppression work. Each bag has two metal filler vents and two spreader-type rubber plugs, attached with chains. When not in use the bag can be rolled into a small, compact bundle. Cost, about $1.80.

Bag, Water, Knapsack-Insert.—The knapsack-water bag (fig. G-2) is designed for use with a knapsack of suitable size, but it may be used with a packboard if encased in a light canvas bag, for support and protection. A small hole in the bottom of the knapsack or protective bag is necessary to accommodate the outlet cock and hose nipple. The Forest Service knapsack specification provides for this, as an optional requirement.

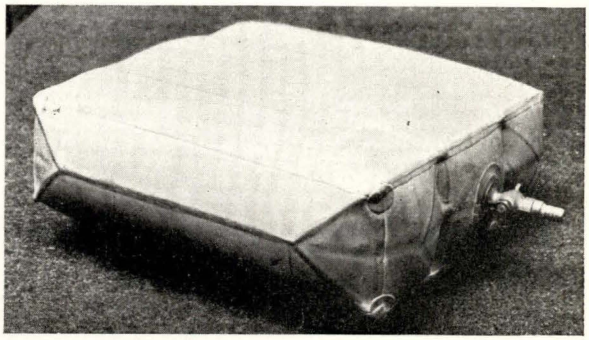


FIGURE G-2.—Knapsack-insert water bag.

The knapsack-insert bag can be used for transporting drinking water or in connection with a standard back-pack pump. It is particularly useful to smokechasers traveling on foot, as it can be rolled up and placed in the pack. Because it is light and compact, it can be carried under conditions where carrying a back-pack can is impracticable.

The material is highest quality sheet rubber, which deteriorates slowly, with proper care, and can be patched the same as inner tubes for automobile tires.

The bag is 13 inches wide, 14½ inches long, and 4½ inches deep, and holds approximately 5 gallons. Two partitions hold the bag in shape when filled. The filler vent is 2 inches in diameter, with screw cap. A ½-inch drain cock, with ⅜-inch hose nipple, is installed at bottom center. Weight of bag when empty, approximately 2½ pounds. Cost, approximately $6.

Cans, Milk.—The standard milk can often proves useful in fire-control work for transporting water or food. It may be purchased under Federal Specification No. RR-C-83. Specified minimum weights for the 5-gallon and 10-gallon sizes are, respectively, 13 pounds and 22¼ pounds. Estimated costs are $5 and $7.

Can, Water, Horse-pack. — This can is sturdily constructed of 24-gage galvanized metal to withstand exceptionally rough handling. It is particularly suited to the transportation of water, oil, or other liquid on a pack animal or in a truck or automobile. The can is 11½ by 7½ inches, by 14½ inches high, and holds approximately 5 gallons. It has a galvanized iron loop handle and a 2-inch brass filler vent and screw cap secured with chain. The cost is approximately $3.75. This can is shown in figure G-3.

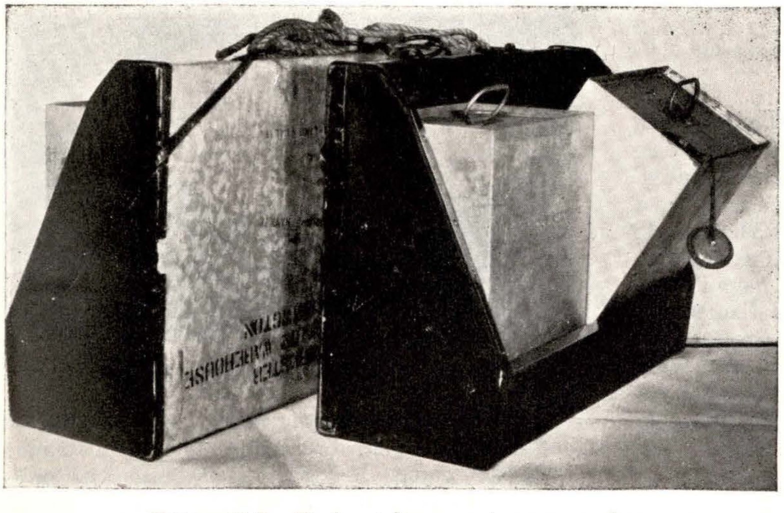


FIGURE G-3.—Horizontal-type water-can carrier.

Carrier, Water Can, Horizontal Type.—This carrier (fig. G-3) is designed to accommodate two 5-gallon water cans (described above). One carrier and two full cans make a suitable side pack for an animal. The cans are so designed that they may be filled in place while packed on an animal, or they may be removed from the carrier without removing the carrier from the animal.

The bottom, ends, and front of the carrier are ¾-inch select pine. The back is 30-gage galvanized iron, and the ends are reinforced with iron. Two-inch iron rings are provided at the top of the carrier so that it may be hung on a pack saddle with ropes or leather straps. The cost per carrier is approximately $5.

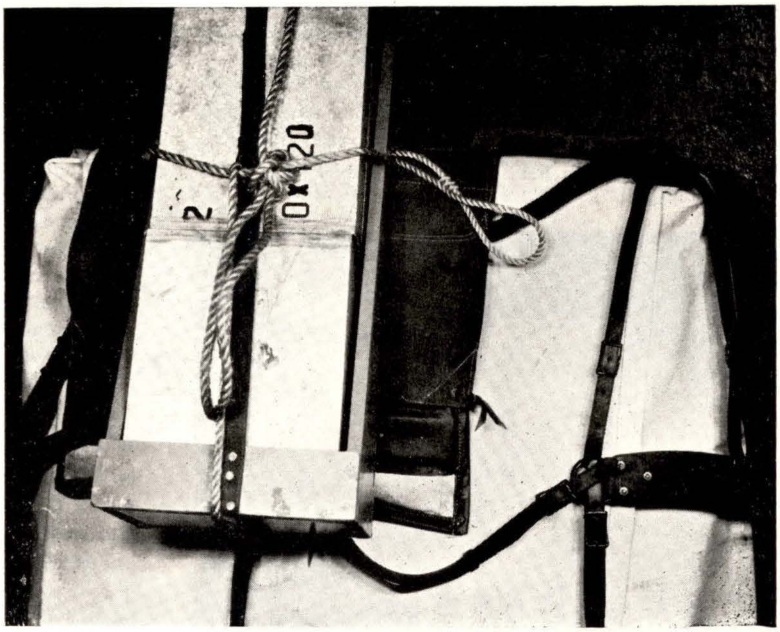


FIGURE G-4.—Vertical-type water-can carrier.

Carrier Water Can, Vertical Type.—The vertical-type water-can carrier (fig. G-4) is designed to carry two of the standard horse- or truck-transporting cans. The only advantage in this type of carrier over the horizontal-type carrier is that it can be manufactured easily by anyone possessing the specification.

It is constructed entirely from ¾-inch common lumber, cement-coated nails, and metal box strapping. A harness-leather strap is used to hold the cans in place in the carrier.

The disadvantages of this type of carrier over the horizontal type are: (1) It is not constructed as sturdily and therefore will not last as long, and (2) it is good only for transporting water since it will not protect the animal from spilled oil when oil is transported. Cost $1.

Tanks, Water, Horse-Pack.—The tanks shown in figure G-5 are designed for carrying water on pack horses. Equipped with a ¾-inch hose bib and a short piece of hose, they are convenient for filling back-pack cans and canteens on the fire control line, and also for supplying water to fire camps where no other source of water is available.

Dimensions of each tank are: Length 19½ inches, height 19½ inches, maximum thickness 8 inches. The weight is 17 pounds and the capacity 10 gallons. The tanks are made in pairs, the outlets being at the rear. The cost is approximately $20 per pair.

Note: Figure G-5 shows a 2-inch canteen top. Since the picture was taken, a 3-inch brass collar has been substituted.

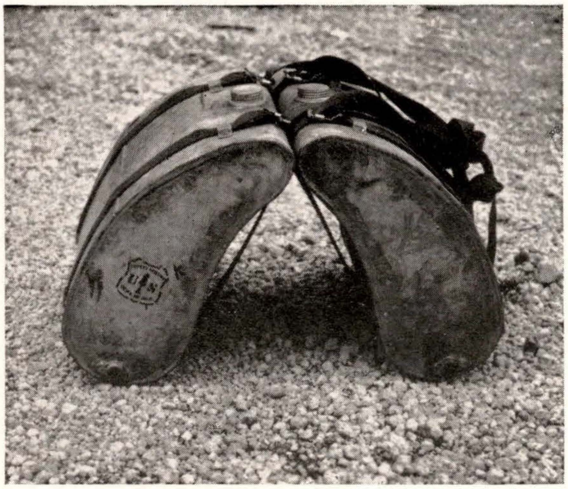


FIGURE G-5.—Horse-pack water can, pair.

SECTION H

PACKING EQUIPMENT

Board, Pack, Clack.—A lightweight, skeleton pack board or frame of sufficient strength to stand heavy use in packing fire equipment (fig. H-1). Designed and constructed so that load may be hung high or low according to individual requirements. Usually the load is wrapped in light canvas. Board is made of clear, straight-grained hickory, joined with copper rivets; carrying and lash straps of webbing. Length of board, 22 inches; width, 10 inches, except bottom cross member which is 16 inches. Forest Service units may obtain these boards from Region 1, where they are manufactured. Weight, 1 pound; cost, 95 cents.

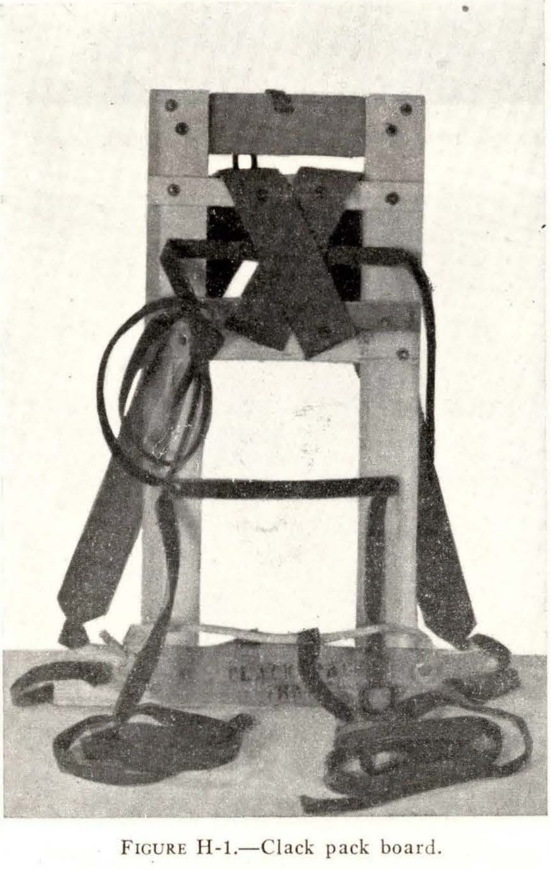


FIGURE H-1.—Clack pack board.

Canvas, Back-Pack, Cargoing.—Suitable material for cargoing articles to be carried on pack boards may be purchased under Federal specification No. CCC-D-761, B-1, type 1, either class A, gray, or class B, dyed and finished. The width and weight should be specified. Eight-ounce duck is suitable but a lighter or heavier product may be used. The width should be not less than 36 inches.

Knapsack (Packsack).—Made of No. 10 duck, olive drab and waterproofed duck, as may be required (fig. H-2). Size 6½ by 14 by 17 inches high, with flap 16½ inches long and 16 inches wide. Has inside pocket 8 by 12 inches and inside tie straps at top. Shoulder straps are of 2¼-inch webbing, and both shoulder and flap straps are secured at outer ends with buckles. The specification provides that a 2-inch reinforced slit in the center of the bottom may be required, with an inside flap for covering the slit when not in use. This permits use of the standard knapsack with the knapsack insert water bag, obviating the need for a special knapsack for this purpose. Approximate cost, $5.

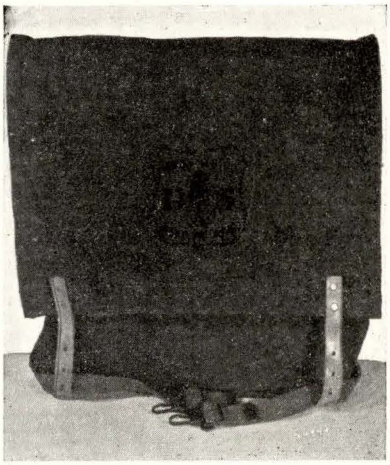


FIGURE H-2.—Knapsack.

Board, Pack, Stampede, with Bag.—This pack board, with bag, was specially designed for use by smoke-chasers and suppression crews. The bag provides ample space for necessary articles, including rations for 72 hours. The board is made of spruce and strung wtih seining twine. The use of twine instead of canvas provides maximum ventilation, conformation to the back, and lightness. Most men who have used this pack board prefer it to one of canvas.

The pack board, with bag, as illustrated in figure H-3, is covered by Forest Service specification, weighs approximately 5 pounds 10 ounces, and costs approximately $7.50. Variations in construction details may be made if desired; e.g., leather carrying straps may be substituted for cord webbing, leather buckle patches and corner reinforcing may be added, ¾-inch rings may be substituted for buckles on carrying straps, and leather thongs may be used instead of twine to fasten the bag to the board.

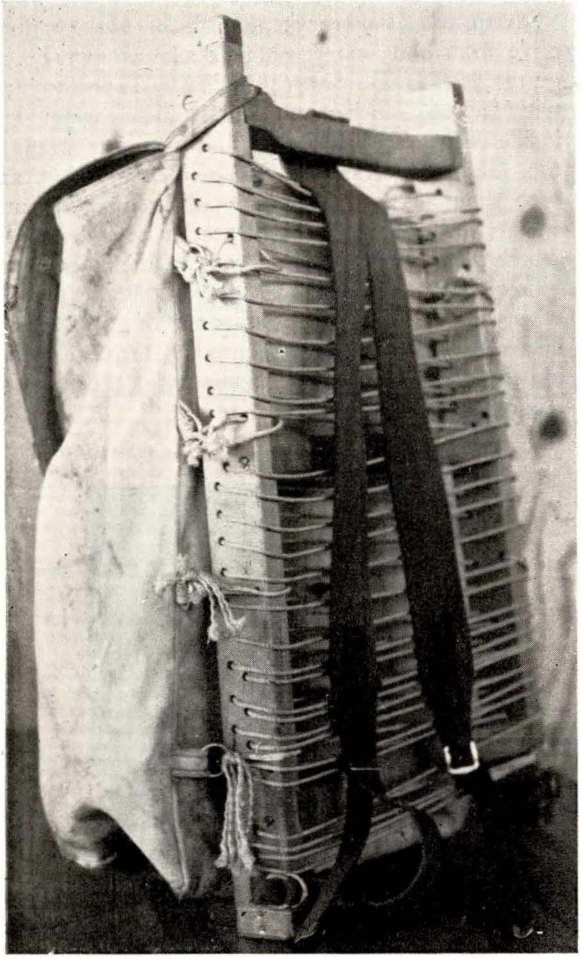


FIGURE H-3.—Stampede pack board, with bag.

Boards, Pack, Canvas-Lined. — Two types of canvas-lined packboards on the market are shown in figures H-4 and H-5. One of these (H-4) is a plain board with collapsible frame, weighing 4½ pounds, and costing about $5. The other (H-5) is equipped with a bag, which can be detached quickly by removing a rod at either side. It weighs 4⅝ pounds and costs approximately $6.50 with bag.

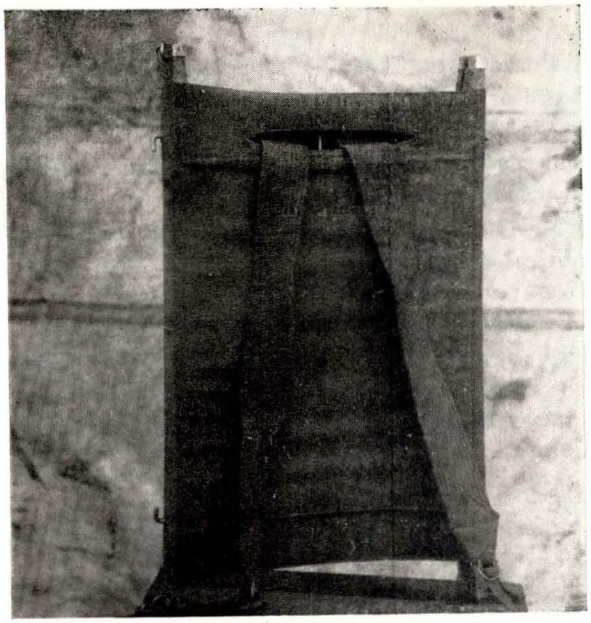


FIGURE H-4.—Collapsible canvas-lined pack board.

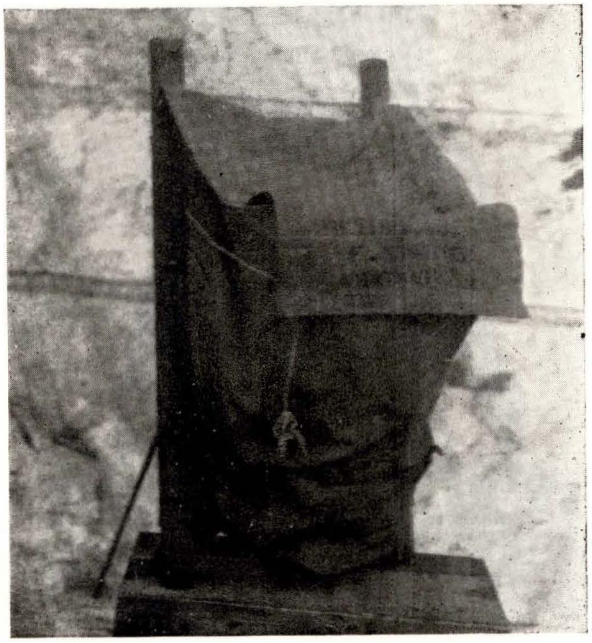


FIGURE H-5.—Detachable canvas-lined pack board.

Board, Pack, Molded Plywood.—This pack board (figure H-6) was developed and manufactured for the Army. It is made of a single piece of ¼-inch waterproof plywood, steam-bent to form a flat surface for the load and rounded edges which are connected to a piece of canvas with cord lacing. Hooks are provided at the sides and a lash rope is attached at the bottom. A bag similar to the one shown in figure H-5 can be attached to the hooks if desired. For better ventilation, cord lacing can be substituted for the canvas by boring additional holes in the edges of the plywood. This board has been found satisfactory for packing heavy loads, and the plywood does not deteriorate in wet weather. It is 24 by 15½ inches in size and weighs 4⅝ pounds.

Packsaddle, Decker.—The Decker packsaddle was developed in Region 1 a number of years ago by outside agencies in the business of commercial packing (figs. H-7, H-8). It is especially adapted to heavy-duty packing. The tree consists of cottonwood side bars, held in place by two steel bars or forks instead of the usual hardwood cross-pieces. It is outfitted with a complete aparejo, pad, breeching, and breast straps. Only one cinch is required.

This particular type of saddle is used almost universally throughout Region 1 and in some parts of other regions. Wherever it has been used to any great extent by packers, it has been proclaimed superior to the cross-tree packsaddle. In a few instances where the Decker has first been tried, objections have been voiced. Upon investigation of these cases it has been found that the saddletrees were not fitted to the animals upon which they were used. A particularly outstanding feature of the Decker saddle is that the tree can be shaped to fit an individual animal simply by heating and bending the steel forks. Approximate cost, $35.

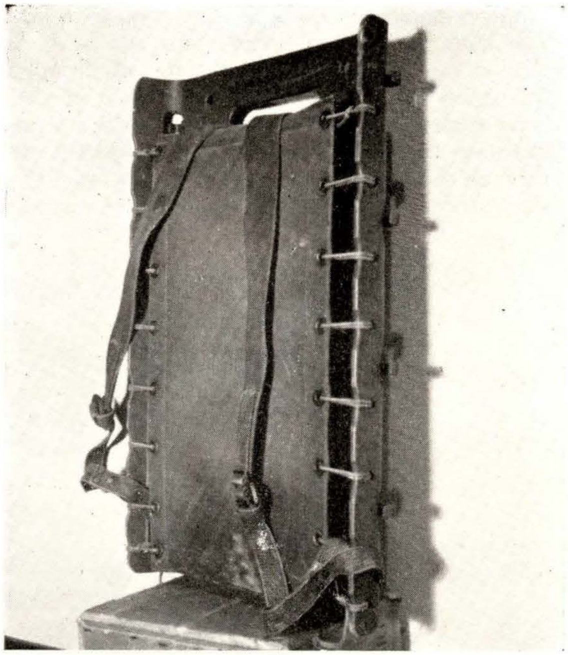


FIGURE H-6.—Pack board of molded plywood.

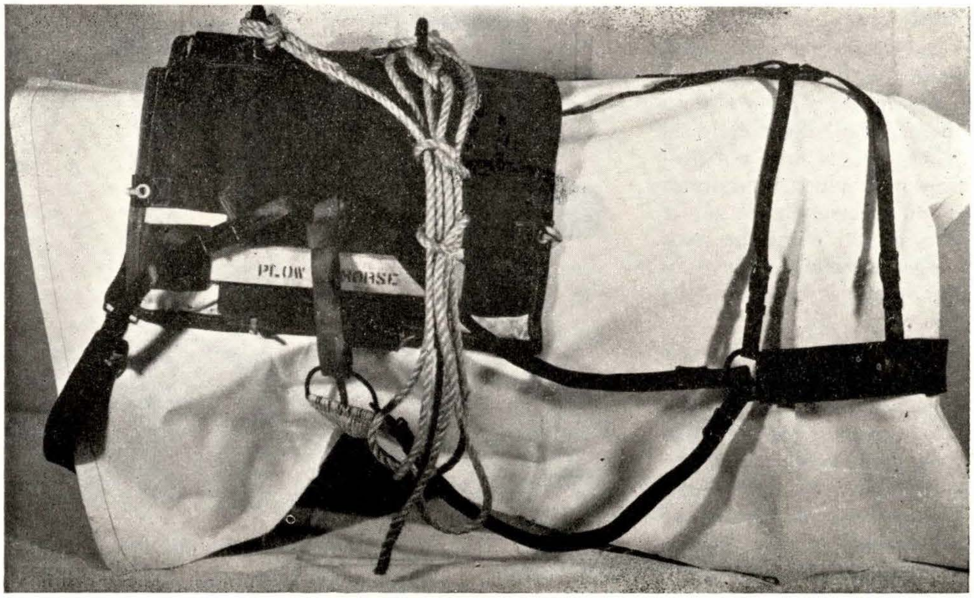


FIGURE H-7.—Complete Decker packsaddle with sling ropes.

The specification covering this item provides for a complete saddle, including Decker tree, aparejo, pad, breeching, breast strap, latigo straps, and cinch. Since Region 1 uses the Decker packsaddle only throughout the region and always has a surplus stock on hand, it is recommended that Forest Service units desiring to purchase this particular type of equipment do so through the Region 1 procurement division, in order that satisfactory saddle may be secured. Cost, $35.

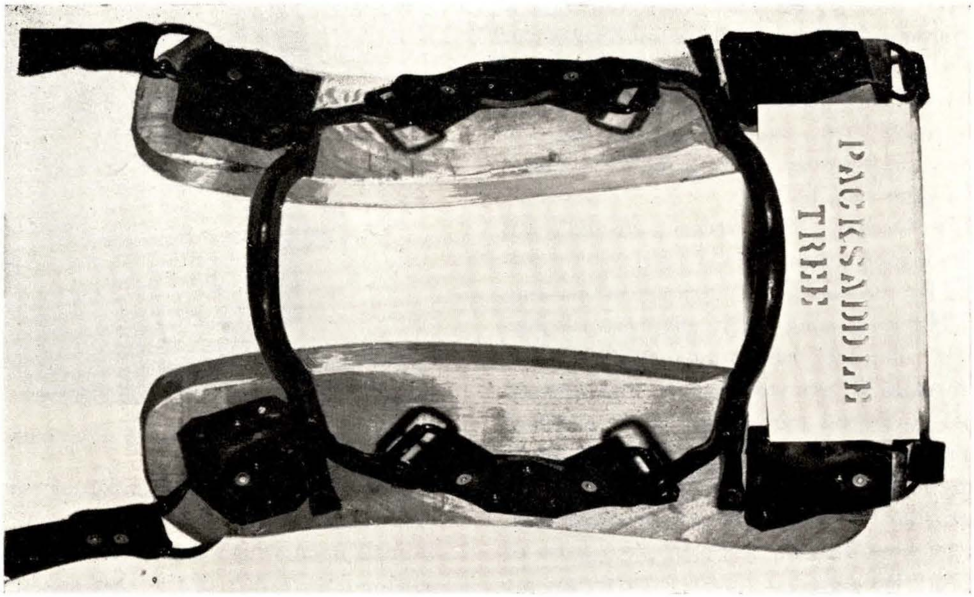


FIGURE H-8.—Decker packsaddle tree, illustrating steel cross bars and rigging strap attachments.

Packsaddle, Cross-Tree.—The cross-tree type of packsaddle is the old conventional style, familiarly known as the sawbuck type. It consists of cottonwood side bars or backpieces, fastened together with hardwood cross bars. The saddle is equipped with breeching, breast strap, and double-rig cinches and latigoes. It does not provide an aparejo pad, which necessitates using more padding beneath the saddle to protect the animal from the pack load. The type of tree employed in this particular saddle is known as the Ole Hagen pattern.

The specification covering this equipment will secure a packsaddle as described above and as illustrated in figure H-9, except for the extended hardwood cross bars which have been modified so that they do not extend below the cottonwood backpieces of the tree and except for the cinches which are as described in the following item. Cost, about $15.

Cinch, Packsaddle.—The Forest Service specification covering this item provides a mohair cinch approximately 25 inches in length and constructed for heavy use. This particular type of cinch is quite commonly used. Approximate cost, 75 cents.

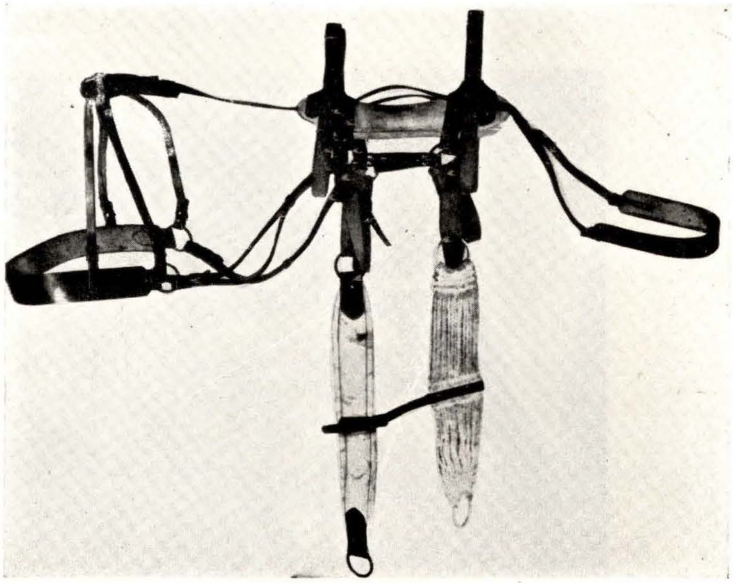


FIGURE H-9.—Cross-tree packsaddle.

Cinch, Lash.—The lash cinch is used in connection with a lash rope to secure the load on a cross-tree packsaddle. The Forest Service specification provides for a cinch 4 by 27 inches, of three-ply extra heavy webbing, with a dee ring at one end and a hook at the other. Approximate cost, 75 cents.

Latigo Packsaddle.—Latigo straps of a quality suitable for pack transportation can be obtained at about $1 by using the following specification:

Specification—Latigoes shall be constructed from grade No. 1 latigo leather to the following dimensions: Length shall be not less than 7 feet, 2 inches;

width shall be not less than 1⅝ inches; thickness shall be not less than three thirty-seconds of an inch. One end of latigo shall be tapered beginning at a point approximately 1 foot from that end and tapering to a width of seven-sixteenths of an inch. The other end shall not be tapered.

Blanket, Packsaddle.—A good, serviceable, wool-filled blanket can be obtained for about $3 by using the following specification:

Specifications.—Wool-filled blanket 66x84 inches, in accordance with type 2, table 1, of Federal specification No. DDD-B-421a, as amended. Weight shall be 4 or 5 pounds, as specified.

For rough-country packing, many packers prefer a single fold, all-wool, 4-pounds, regular saddle blanket, as it has less tendency to wrinkle and injure the animal's back. Such a blanket can be purchased for about $3.

Pad, Packsaddle.—A quilted pad, approximately 30 inches long and 36 inches wide. Each side of the pad is filled with approximately 1½ pounds of pure deer hair and quilted. This pad is specially designed for heavy use. Approximate cost, $3.

Halter, Leather.—A heavy halter, designed for leading mules. Made of first-grade harness leather, with 1¾-inch crown piece, cheeks, and chin strap, lined with latigo leather. Face piece, 1¼-inch latigo leather, split at both ends. Draw-type chin strap. Throat latch fastened with harness snap. Approximate cost, $3.25.

Halter, Rope.—A substantial halter for light use, where the more expensive leather halter is considered unnecessary. Made of 7/16-inch hard-braided cotton rope, with malleable metal clamps, cadmium finished. Weight approximately 1 pound. Specification gives dimensions for large and medium sizes. Approximate cost, 80 cents.

Bag, Packsaddle.—Designed for use with cross-tree saddle, but may be used with Decker saddle by buckling the hanger straps through the cross bars on the saddle. Made of No. 2 medium-texture duck, with straps and ends of harness leather. Size approximately 12 by 25 by 17 inches (figure H-10). Weight, 6 pounds; approximate cost, $7.

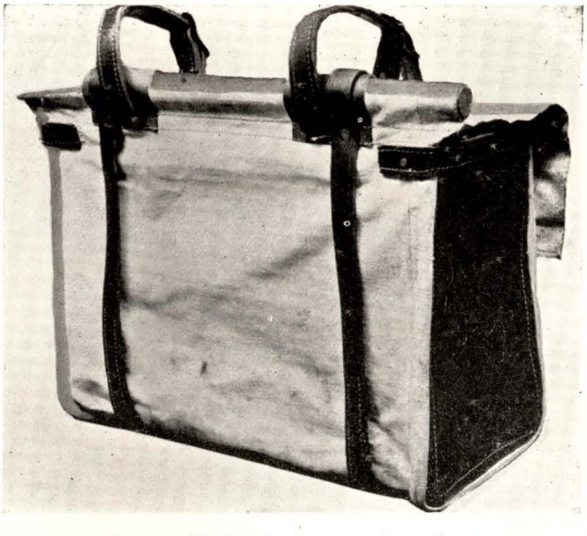


FIGURE H-10.—Canvas packsaddle bag.

Cover, Pack, Large.—This pack cover is constructed of heavy duck and is 6 by 12 feet in size. Grommets are provided at all four corners and at the center of each side so that the cover may be used for other purposes, such as a camp shelter. This type of pack cover is needed only where it is desirable to cover the entire load after packing. For small pack covers or cargo mantas, refer to "Cover, Pack Manta." Approximate cost, $5.

Cover, Pack Manta.—The small-size pack cover, better known as the cargo manta, is used to cargo individual side packs for animal transportation. It can be cut from any good grade of heavy duck 72 inches in width; hems or grommets are unnecessary. The following standard specification will obtain canvas suitable for the purpose:

Specification.—Natural finish No. 6 hard-texture gray duck 72 inches in width, in accordance with Federal specification No. CCC-D-771a, as amended, type 1, table 1. Approximate cost, $3.

Goggles, Horse.—A canvas hood, fitted with transparent eye pieces, for use when transporting horses or mules in trucks or trailers. It can be adjusted to fit most animals and is an inexpensive means of protecting their eyes from dust and wind. Its use makes unnecessary the construction of windshields on trucks and trailers where weather conditions do not require additional protection. Approximate cost, $5.

Bag, Nose Feed.—The Forest Service specification provides for a feed bag similar to the Army bag shown in figure H-11. This type of feed bag is considered superior to the bucket type with a single head strap.

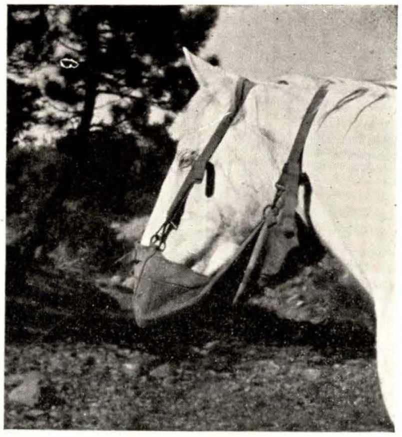


FIGURE H-11.—United States Army-type nose feed bag.

SECTION I

HAND TOOLS AND CONTAINERS

Ax, Double-Bit, 3½-Pound, Chopping.—The western pattern ax (fig. I-1, 3) has been adopted as the standard ax for Forest Service use in all ordinary chopping work. The specification includes an outline drawing of the type of ax to be furnished and will provide a first-grade 3½-pound double-bit ax. Length of bit, 10 inches; width, 4⅝ inches; approximate cost, $3.

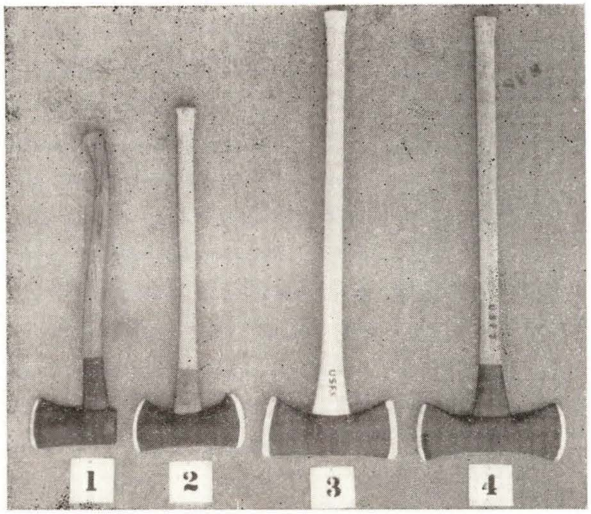


FIGURE I-1.—Forest Service ax patterns: 1, 2¼-pound ax; 2, cruiser ax; 3, chopping ax; 4, felling ax.

Axe, Double-Bit, 3½-Pound, Felling. — The Young's pattern ax (fig. I-1, 4) has been adopted as standard for Forest Service use where a felling-type ax is required. The specification requires a bit approximately 11½ inches long by 4½ inches wide. The weight of the ax is about 3½ pounds. Axes meeting this specification will be first-grade tools. Approximate cost, $3.

Ax, Double-Bit, 2½-Pound, Cruiser Pattern.—This ax is similar to the western pattern, but weighs only about 2½ pounds (fig. I-1, 2). It is particularly adaptable for use as a saddle or car ax, or as a lightweight blazing ax. It is provided with a 27-inch double-bit handle. Approximate cost, $3.

Ax, Single-Bit, 3½-Pound. — The 3½-pound single-bit ax is used widely in the East for the same purposes as the double-bit ax is used in the West. It is particularly useful for knocking old logs and stumps to pieces in mop-up work. It is safer than the double-bit ax in the hands of an untrained man. Dimensions of the type shown in figure I-2 are: Width of bit, 4⅞ inches; width of head, 3½ inches; depth of eye, 4 inches; length of handle, 30 inches. The cost is approximately $3.

Another design is similar to the lighter single-bit axes shown in figure I-1.

Ax, Single-Bit, 2¼-Pound.—This light single-bit ax (fig. I-1, 1) is especially useful in fire camps for such work as sharpening and driving stakes and splitting kindling. It has a 26-inch handle. Approximate cost, $2.

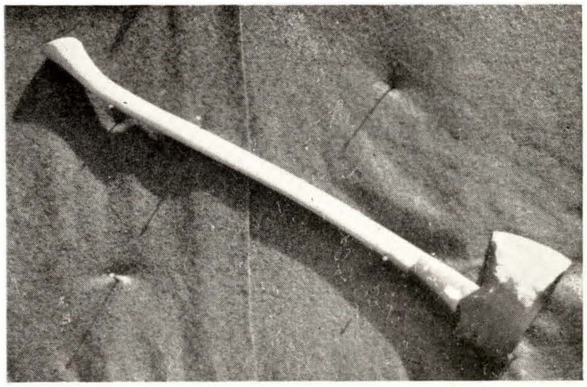


FIGURE I-2.—Single-bit ax, 3½-pound.

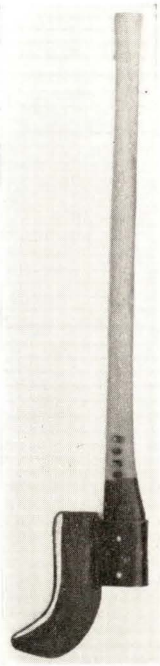


FIGURE I-3.—Single-edge brush hook.

Brush Hook, Single Edge.—The Forest Service specification describes a brush hook which is designed for heavy service (fig. I-3). It is much better than an ax for slashing work and cutting small material under 4 inches in diameter. The tool is constructed of first-quality tool steel which will hold an edge in difficult cutting work. It is handled with a straight type of single-bit ax handle, which is held in place by two ⅛-inch rivets after having been wedged. Should the handle become loose, it can quite easily be tightened with the rivets through the eyepiece. Weight, 5 pounds; approximate cost, $2.50.

Tool, Pulaski.—The Pulaski tool (fig. I-4) is a combination ax and grub hoe, weighing approximately 3¾ pounds, with a regular double-bitted ax handle. It is constructed of first-grade tool steel and can be used as effectively as a regular ax on small trees, brush, and logs. In large timber it is not so effective because a large rounded notch is required to avoid striking the side of the grub hoe on the edge of the notch.

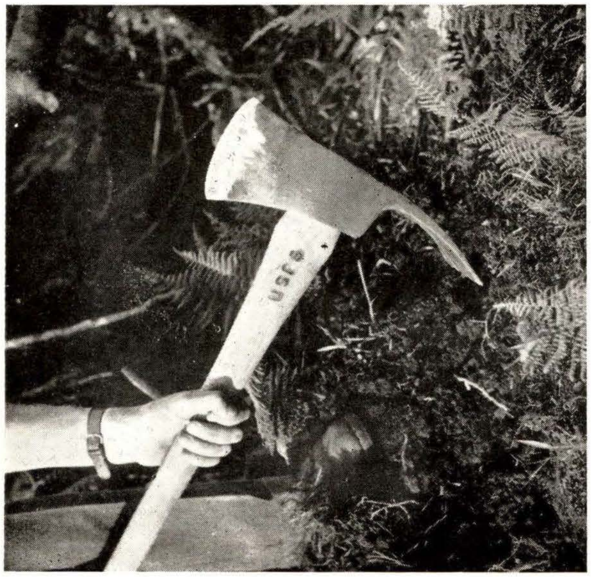


FIGURE I-4.—Pulaski tool.

The hoe part is 6 inches long and 3⅜ inches wide, which is narrower than a regular grub hoe and less effective for digging in soil free from boulders. In rocky soil the Pulaski is more effective in removing duff from between crevices. It is also a very effective tool in mop-up work, since it can be used for both cutting and scraping.

The great advantage of the Pulaski tool lies in combining a cutting and digging tool. In the progressive method of line construction ability to shift men readily from the clearing to the digging squads and vice-versa is essential. The Pulaski makes this possible with a minimum of lost time.

This tool is used extensively throughout the western regions and to some extent in the East. Its cost is approximately $3.25.

Brush Hook, Double Edge.—The double-edge brush hook (fig. I-5) is a well-balanced tool which is preferred to the single-edge brush hook in some localities. The inner, concave blade is normally used for brushing out ahead of a line-building crew. The back edge is used as an ax for cutting heavy material or scraping fire out of logs and stumps. It is quite effective in limbing and cutting material up to 6 inches in diameter.

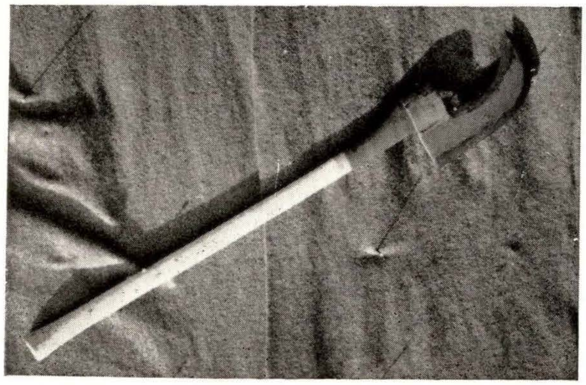


FIGURE I-5.—Double-edge brush hook.

Dimensions: length, 36 inches; blade, 3¼ inches wide, 11¼ inches long, and 8 inches inside length; weight, 4 pounds, 10 ounces. Approximate cost, $2.75.

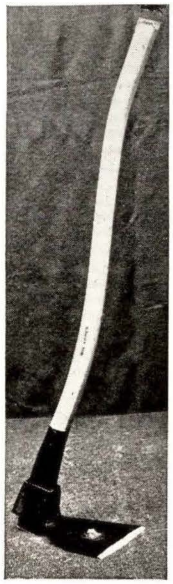


FIGURE I-6.—Adz hoe.

Hoe, Adz.—The adz hoe (fig. I-6) is constructed of first-quality tool steel, and is superior to the ordinary hazel hoe. It is particularly useful for trenching in heavy duff and roots, such as are found in the Douglas-fir region. Under such conditions, trenching can be done much faster with it than with a Pulaski tool. However, a narrower digging tool is more suitable in rocky terrain. As the name indicates, this tool is designed for a standard adz handle. The hoe is 8½ inches long and 6 inches wide. Weight without handle, approximately 2¾ pounds. Approximate cost, $2.50.

Tool, McLeod.—The McLeod tool (fig. I-7, 1) is a combination heavy-duty rake and hoe suitable for cutting matted brush cover and heavy duff, and for general rake work in clearing medium cover. It is not well suited for rough terrain where much loose rock and small shrubs such as huckleberry are found. The rake section is of the nonclogging pattern. The entire blade of the tool is pressed from saw-quality tool steel and tempered to a medium hardness. The blade is fastened to a 48-inch straight hoe-pattern ash handle with an 8-inch steel ferrule. The ferrule is riveted and welded to the steel blade and a rivet is placed through the ferrule and the ash handle. The width of both the cutting edge and the rake side of the tool is approximately 11 inches. Weight 5 pounds. Approximate cost, $3.

Tool, Combination Rake and Cutting.—The combination rake and cutting tool is known in some localities as the Council or Rich tool (fig. I-7, 3). It is constructed from 4 mowing machine sickle cutter sections, fastened to a piece of 1-inch angle iron to which is welded a steel planter's-hoe eye. This tool is particularly adaptable to fire-trench work in light brush and in duff containing small roots, etc., and can be used for cutting and digging or raking. The cutter section is 11 inches wide and has replaceable teeth. The tool is equipped with a 60-inch straight planter's-hoe handle. Weight, 4 pounds; approximate cost, $2.

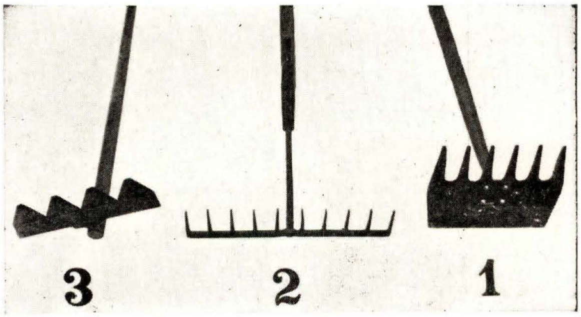


FIGURE I-7.—Fire rakes: 1, McLeod tool; 2, asphalt type rake; 3, combination rake and cutting tool.

Swatter, Fire.—This tool is designed for use in suppressing fires in grass and similar light fuels. (See figure I-8.) It is constructed of belting not less than 15 inches long and 12 inches wide, which is fastened to a steel shank and handled with a hoe-pattern ash handle approximately 5 feet in length. The purpose of the fire swatter is, as the name indicates, to beat out fires. It has a smothering action which quickly extinguishes fire. Weight 5 pounds; approximate cost, $3.

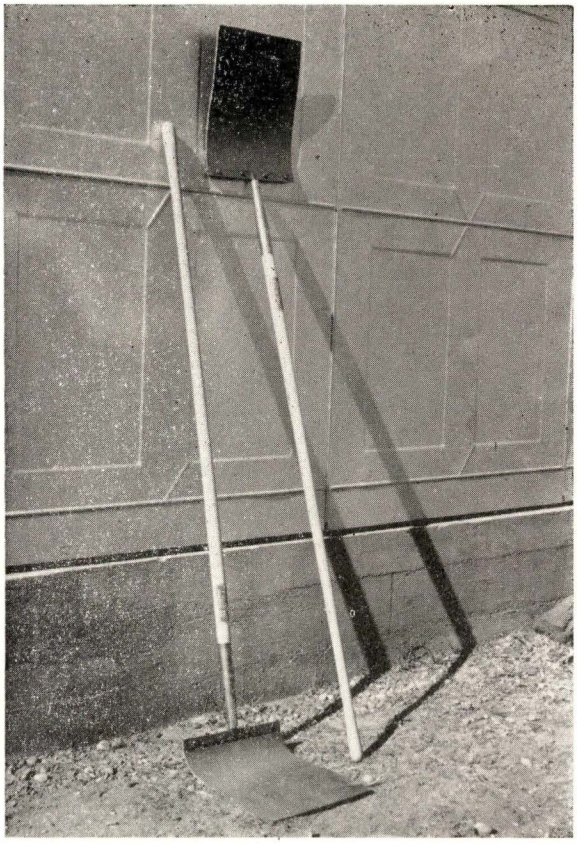


FIGURE I-8.—Fire swatter.

Mop, Rotary, Fire.—The rotary mop, illustrated in figure I-9, works on the same principle as does the fire swatter, which is an effective means of combating fires in grass types. It has the advantage, however, of carrying more beaters to strike the fire than does the swatter.

In appearance, the mop is like a very light lawn mower, but it has no gears, and rubber mats or mops take the place of blades. In operation, the machine is pushed along the burning edge of the fire. The mops, six in number, rotate and beat the ground.

The central cylinder is almost as large as the wheels so that after each mop strikes the ground, it is wound up on this cylinder. When released, the mop uncoils and strikes the earth. Part of the force of the blow comes from the spring of uncoiling and part from centrifugal motion. It operates equally well backward.

This is a new machine and has not been thoroughly tested, but indications are that it is a very efficient tool if used on grass. It is not suitable for use in rocky or brushy areas. Weight 20 pounds. Approximate cost, $20.

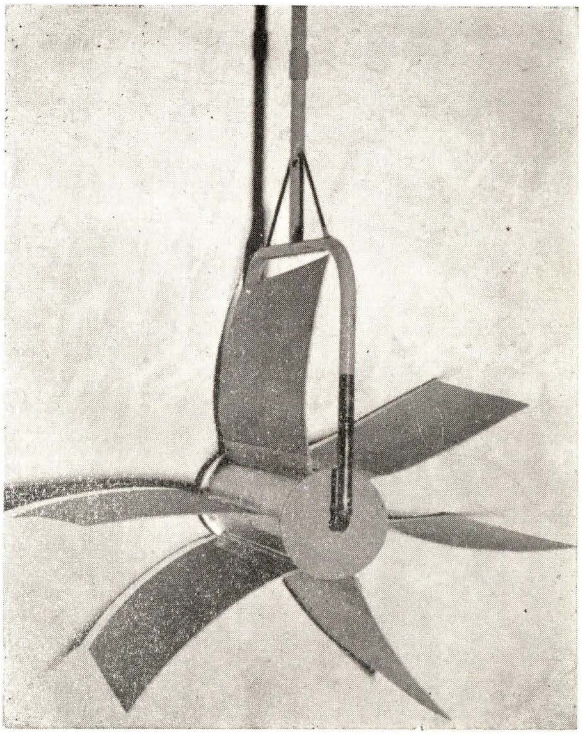


FIGURE I-9.—Rotary fire mop.

Shovel, Long-Handle, Round-Point, No. 2.—The No. 2 shovel (fig. I-10, 1) is used to a considerable extent in fire control work, although it has been superseded by the No. 0 size in many places. Weight approximately 5½ pounds. Cost approximately $1.85. In ordering No. 2 shovels, the following specification may be used. Slightly different dimensions may be specified if desired.

Specification—In accordance with Federal Specification No. GGG-S-326, as amended, Type IV, long-handle, plain-back, dimensions and tolerances to be as follows:

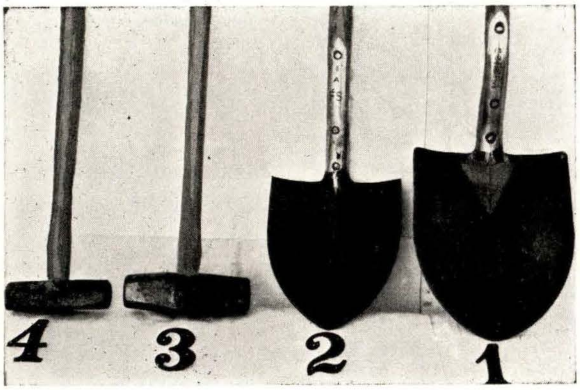


FIGURE I-10.—1, No. 2 long-handle, round-point shovel; 2, No. 0 long-handle, round-point shovel; 3, 8-pound striking hammer; 4, 4-pound striking hammer.

Dimensions	*Tolerance*
Blade width, 9½ inches	Plus or minus ¼ inch
Blade length, 11⅜ inches	Plus or minus ½ inch
Blade thickness, .08 inch	Plus .015 inch; minus .005 inch
Handle length, 48 inches	Plus or minus 1½ inches
Blade lift, 7 inches	Plus or minus ½ inch
Handle lift, 30 inches	Plus or minus 1½ inches

Shovel, Long-Handle, Round-Point, No. 0.—The No. 0 shovel (fig. I-10, 2) has been adopted as standard for fire control work in several Forest Service Regions, because it is considered adequate and, in fact, superior to larger shovels for this kind of work, and it has the advantage of being lighter and more convenient to transport and use. Weight approximately 3½ pounds. Cost approximately $1.40. In ordering the following specification should be used:

Specification—In accordance with Federal Specification No. GGG-S-326, as amended, long-handle, plain-back, except that dimensions and tolerances shall be as follows:

Dimensions	*Tolerance*
Blade width, 8 inches	Plus or minus ¼ inch
Blade length, 10 inches	Plus or minus ½ inch
Blade thickness, 0.078 inch	Plus 0.015 inch; minus 0.005 inch
Handle length, 37.5 inches	Plus or minus 1 inch
Blade lift, 6 inches	Plus or minus ½ inch
Handle lift, 24 inches	Plus or minus 1 inch
Strap length, 8 inches	Dimension is minimum

Hammers, Striking.—Striking hammers (often incorrectly called sledge hammers) are used in fire control work for driving steel wedges. Two sizes are illustrated in figure I-10, 3 and 4. The 4-pound size is commonly used in connection with fire-line sawing work where the timber is not too heavy. The 8-pound size is needed where large wedges are used. Suitable hammers can be purchased under Federal Specification No. GGG-H-86. Bids should specify type T (striking hammers), class I (long pattern) and give the weight. Hammers will be fitted with handles unless called for without handles. Handles for 4-pound hammers are 16 inches long; those for 8-pound hammers are 32 inches long. Approximate cost of 4-pound size $2.20; 8-pound size $2.80, with handles.

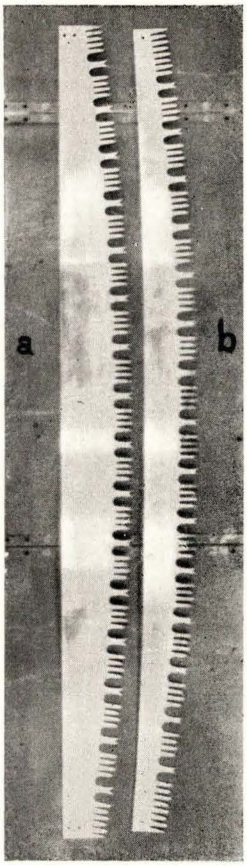


FIGURE I-11.—Crosscut saws: 1, Bucking pattern; 2, falling pattern.

Saws, Crosscut.—Figure I-11 shows western pattern felling and bucking saws. Standard Forest Service specifications require first-quality saws regardless of length and pattern. The cost normally is about $1.75 per foot for felling saws and $2 per foot for bucking saws.

Saw, Buck.—This type of saw has a thin, narrow blade of high-grade steel, ordinarily mounted in a tubular steel frame, but also used in a wood frame, which is preferred in some localities (fig. I-12). Three sizes are available; 30-inch, 42-inch, and 48-inch. The steel frames of the two larger saws are adjustable, with lever action. Approximate retail prices are $3, $6, and $6.50, respectively. The 42-inch saw with steel frame weighs 5½ pounds.

Two different tooth patterns are available. One is similar to the tooth pattern of standard crosscut saws, with four cutters to one raker. The other has four cutter teeth in sequence, but no teeth that serve as rakers only.

This saw is particularly useful where there is a considerable amount of small material to be cut, as it is light and can be used by one man for both felling and bucking, and it cuts very fast, with the minimum of pinching. It is also easy to file and set.

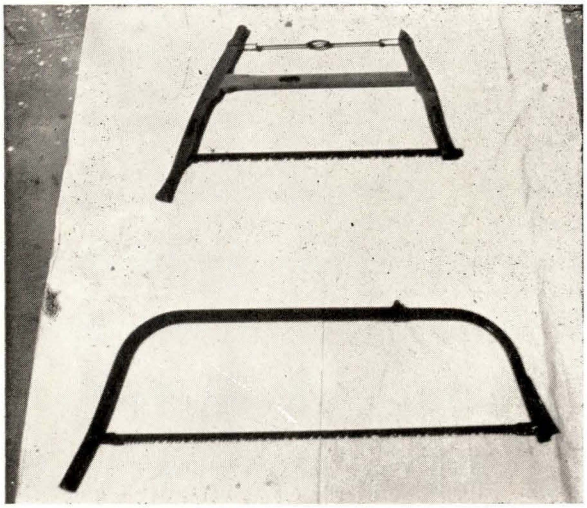


FIGURE I-12.—Bucksaw.

Wedges, Steel.—The Forest Service wedge specification provides for three types of steel wedges, as follows:

1. Light-duty saw wedge available in different weights (fig. I-13, 3, 4).

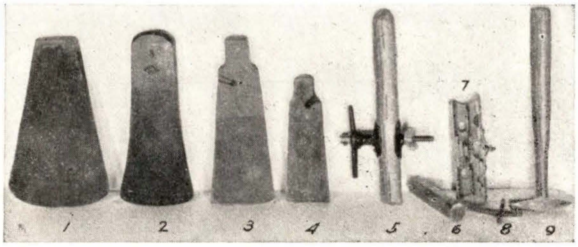


FIGURE I-13.—Timber sawing accessories: 1, 6-pound Pacific Coast bucking wedge; 2, 6-pound Pacific Coast falling wedge; 3, 4-pound light-duty saw wedge; 4, 2-pound light-duty saw wedge; 5, crosscut saw handle; 6 to 9, saw-filing outfit.

2. Pacific coast falling wedge available in six different weights ranging from 5 to 10 pounds (fig. I-13, 2).
3. Pacific coast bucking wedge available in three weights, 6, 7, and 8 pounds (fig. I-13, 1).

The wedges are manufactured from a grade of steel suitable for producing first-quality tools, and they are tempered properly throughout. Approximate cost, 20 cents per pound.

Wedge, Hardwood.—An inexpensive wedge sawed from hickory, oak, or other tough hardwood stock. Approximate dimensions, 10 inches long, 3 inches wide, and one inch thick at heavy end. The three-inch sides are dressed smooth and edges of head are dapped to retard splitting. The manufacture is as simple as possible to reduce cost, which is about 20 cents per wedge. Hardwood wedges are particularly useful for smoke chasers and fire crews who need to fell and buck timber in rough country away from roads, as they are light and can be driven with the side of an ax.

Handle, Crosscut Saw.—A clear hardwood handle equipped with a slotted bolt, rivet, and wing nut for fastening to the saw, and a 4¾-inch metal hand guard (fig. I-13, 5). The handle may be fastened to the saw in either a perpendicular or a horizontal plane. Approximate cost, 50 cents.

Guard, Saw, Fire-Hose Type.—A suitable saw guard can be constructed of condemned 1½-inch cotton-jacketed rubber-lined fire hose. A piece of hose, slightly longer than the saw, is split full length along one side and four ¾-inch harness-leather straps are riveted at equal distances along the length of the hose, to go around the saw and fasten to a buckle riveted to the opposite side of the guard. Still another means of fastening the guard over the saw teeth is to rivet a piece of web strapping about twice the length of the saw to one end of the guard and wind this spirally around both saw and guard, tying it at the opposite end of the saw; or, if the hose is not to be again used as a saw guard, an ordinary piece of baling wire or heavy string will suffice.

Carrier, Timber.—The timber carrier has a 2½-inch hickory handle, 4 feet long, with two duck bill hooks fastened to the center by a steel swivel bolt and a malleable iron clasp (fig. I-14). Logs or other heavy forest material are suspended between the hooks and carried by men at each end of the handle. Because of its specialized function, its use is limited to areas where there is down material to be removed from fire lines, firebreaks, or to other areas to be cleared by manpower. Where more than two men are required to move the logs or poles because of their weight or length, two or more carriers are frequently used. The tool weighs approximately 9 pounds and may be purchased on the market for about $3.50.

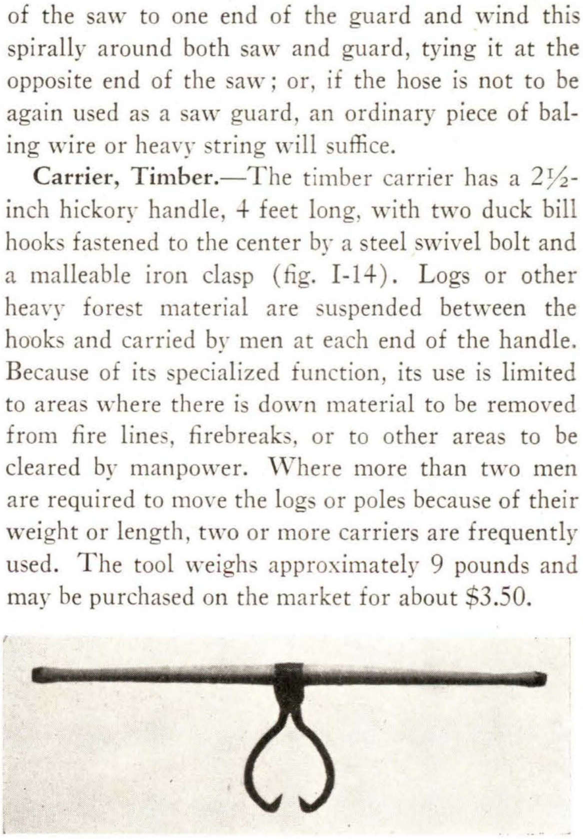


FIGURE I-14.—Timber carrier.

Sheath, Ax, Double-Bit, Western Pattern.—The western pattern ax sheath (fig I-15, 5) is constructed of first-grade harness leather, riveted throughout. It is provided with a japanned harness ring, securely fastened in one end, by which the ax may be carried on a saddle or elsewhere requiring a ring attachment. Filler strips of approximately ⅛-inch thick are riveted around the edges so that the ax bits cannot come in contact with the rivets or cut through the sheath.

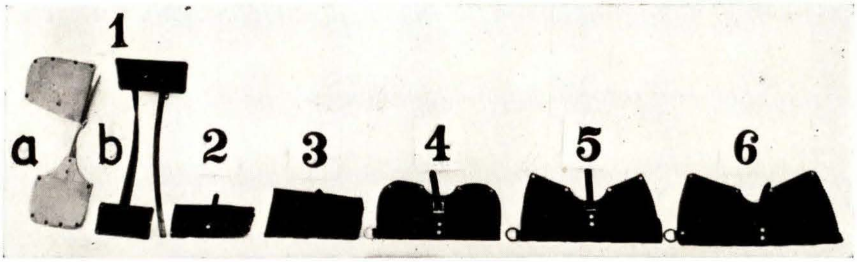


FIGURE I-15.—Sheaths: 1a, standard Pulaski tool sheath; 1b, nonstandard Pulaski tool sheath, a simple design which may be home manufactured; 2, belt ax sheath; 3, boy's ax sheath; 4, cruiser ax sheath; 5, western pattern ax sheath; 6, Young's pattern ax sheath.

Sheath, DB Ax, Metal (Dorr Type).—A metal ax sheath constructed of 20-gage black sheet steel and held on the tool by a web strap. It will fit the western pattern ax or similar axes. It will not work on single-bit axes or double-bit axes smaller than 3½ pounds or larger than 4 pounds.

It consists of two metal sheaths approximately 5¾ x1¾ inches, formed to fit the curvature of an ax blade. In the back of each section is a 5/16-inch maple dowel, against which the sharpened edge of the tool rests when the sheath is in place.

The two sheaths are held snugly in place over the bits by a 1-inch web strap fitted with a buckle. On one side the strap is riveted to the sheath with two copper rivets so the three parts will not become separated. (Fig. I-16.) Weight, ½ pound. Approximate cost, $1.

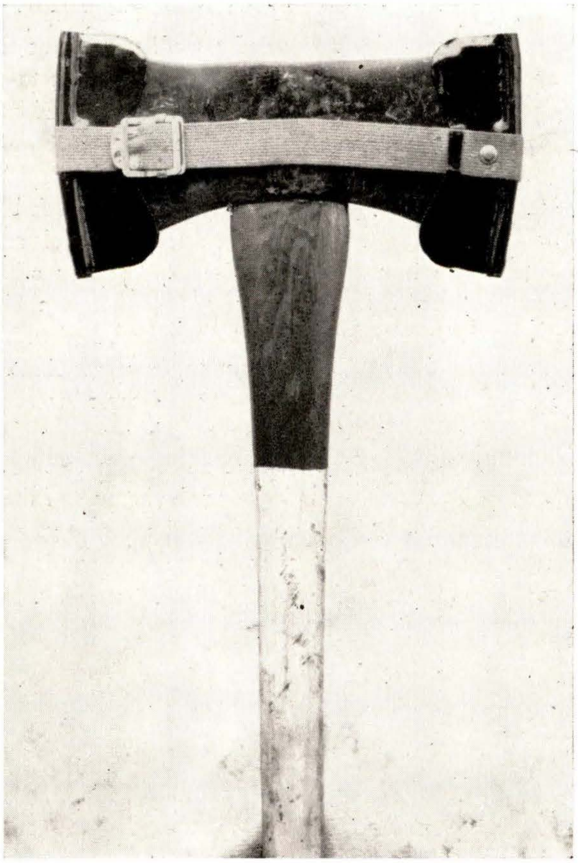


FIGURE I-16—Metal ax sheath.

Sheath, Ax, Double-Bit, Felling.—The same construction as the western pattern ax sheath, but designed to fit a Young's pattern ax (fig. I-15, 6).

Sheath, Ax, Cruiser Pattern.—The same construction as the western pattern ax sheath, but designed to fit the cruiser pattern ax (fig. I-15, 4).

Sheath, Ax, Single-Bit, Boy's Pattern.—Constructed essentially the same as the western pattern ax sheath, but designed to fit the 2¼-pound boy's pattern single-bit ax (fig. I-15, 3).

Sheath, Pulaski Tool, Leather.—Designed to protect both the ax end and the hoe end of the Pulaski tool (fig. I-15, 1). Constructed of first-grade lightweight harness leather, in two parts, fastened together with harness-leather strap and buckle.

Sheath, Pulaski Tool, Metal (Dorr Type).—This metal sheath, designed to protect the sharpened edges of the Pulaski tool from damage while being transported, is constructed of 20-gage black sheet steel and held on the tool by a web strap. It will fit any Pulaski tool which meets Specification No. 355. It will not fit a double-bit ax or other type of chopping tool (fig. I-17).

The complete sheath consists of two metal sheaths, one 5¾ x 1¾ inches and the other 3¾ x 1¾ inches, and a 25-inch length of 1-inch web strap with a buckle. The sheath sections are formed to fit the curvature of the blades. In the back of each section

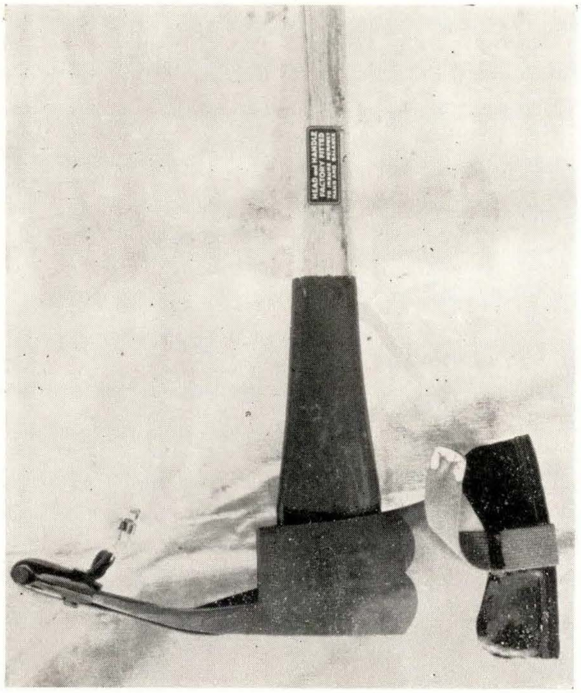


FIGURE I-17.—Metal sheath for Pulaski tool (Dorr type).

is a 5/16-inch maple dowel, against which the sharp edge rests when the sheath is in place. The two parts are held snugly in place over the bits by a 1-inch web strap. One end of the strap is riveted to the digging blade sheath so the three pieces cannot become separated. Weight one-half pound. Approximate cost $1.

Handles, Tool, Long Type, Hickory. — This group includes the striking hammer handles, ax handles, adz handles, and railroad pick or mattock handles. Federal Specification No. NN-H-93, as amended, and the following grades, have been adopted as standard for Forest Service use in fire control work:

B grade for hammers, axes and mattocks.

A grade for adz hoes.

Handles, Tool, Short Type, Hickory.—These handles are for hammers, hatchets, hand axes, and similar small tools. Federal Specification No. NN-H-93, as amended, for B grade handles, has been adopted as standard for Forest Service use in fire control work.

Handles, Tool, Ash.—This group includes handles for forks, hoes, rakes, shovels, and similar tools. Federal Specification No. NN-H-81, as amended, has been adopted as standard for Forest Service use in fire control work; X grade except when an extremely light handle is used in a tool intended for heavy work. In such cases XX grade should be used.

Special Note. — Handles of all kinds should be packed in open crates, as handles packed in tight paper cartons will sweat and mold in storage.

Box, Crosscut Saw.—See plan at end of this section. The box, as shown in the plan, is designed for 12 saws, but dimensions may be varied for a smaller number or for different lengths.

Box, Fire-Tool, Metal, 12- or 15- Man.—This is an upright metal box designed to hold sufficient hand fire tools for a maximum of 15 men (fig. I-18). It is especially well adapted for storage of fire tools in the field, but may be used anywhere. It is not suitable for use in humid climates, as it is not entirely weatherproof and the tools may rust.

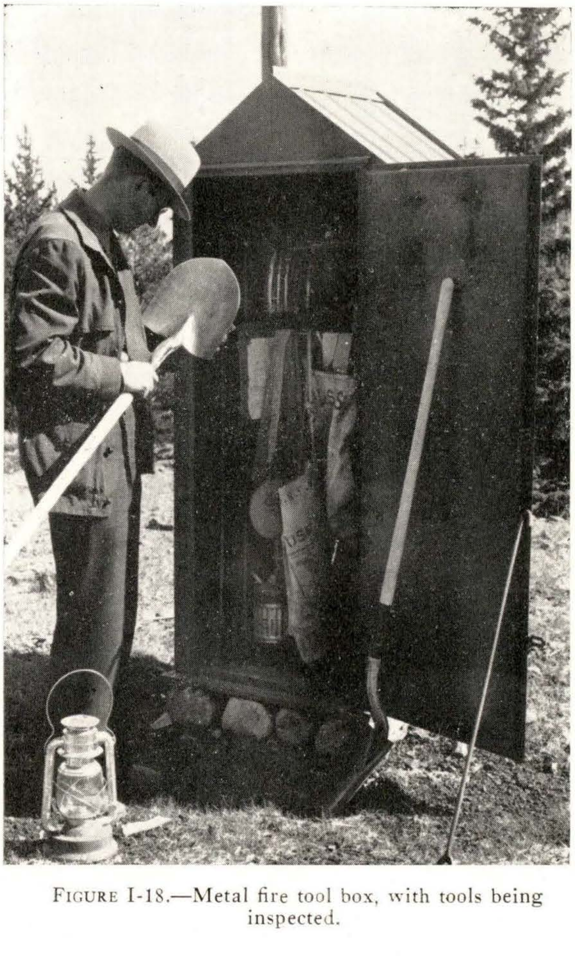


FIGURE I-18.—Metal fire tool box, with tools being inspected.

The box is constructed of 22-gage block sheet steel and fabricated in sections which are easily assembled by bolting together. When set up, the box measures 30 inches wide, 27 inches deep, and 64½ inches high, The roof is V-type with a 12-inch rise. The sides and back have V-ridges for rigidity. The door is the full height and width of the front, which makes removal of tools convenient. It is held shut by one hasp near the top and one near the bottom. A ½-inch iron rod with a hook at one end and a loop at the other is hooked over the top hasp and passed over the loop of the lower hasp. A U-bolt is then passed through the loop in the lower hasp and sealed with a box-car seal. Shovels, axes, Pulaski, and other such tools are suspended on rod brackets, while canteens, canvas buckets, lanterns, etc., are hung on rods.

Weight of box completely assembled, 120 pounds. Approximate cost, unassembled, $30. Painting at least every 2 years is required, using ¼ pint of red enamel.

Note: Figure number I-19 is missing.

Box, Fire-Tool, Metal, 8- to 10-man.—This box (fig. I–20) is constructed of 20-gage galvanized steel, and is designed for mounting in an upright position. It can be used as a truck tool box, but it is not rain-tight in a horizontal position. It has racks for hanging tools and a shelf, 6 by 27 inches, on each side. The maximum length of tools that can be stored in it is 5 feet, 4 inches. The 6-inch panel at bottom front makes cleaning difficult.

Dimensions: Height 6 feet; width 2 feet, 6 inches; depth 2 feet, 3 inches; door full width and 4 feet, 6 inches high. Weight of box, 150 pounds. Approximate cost, $25.

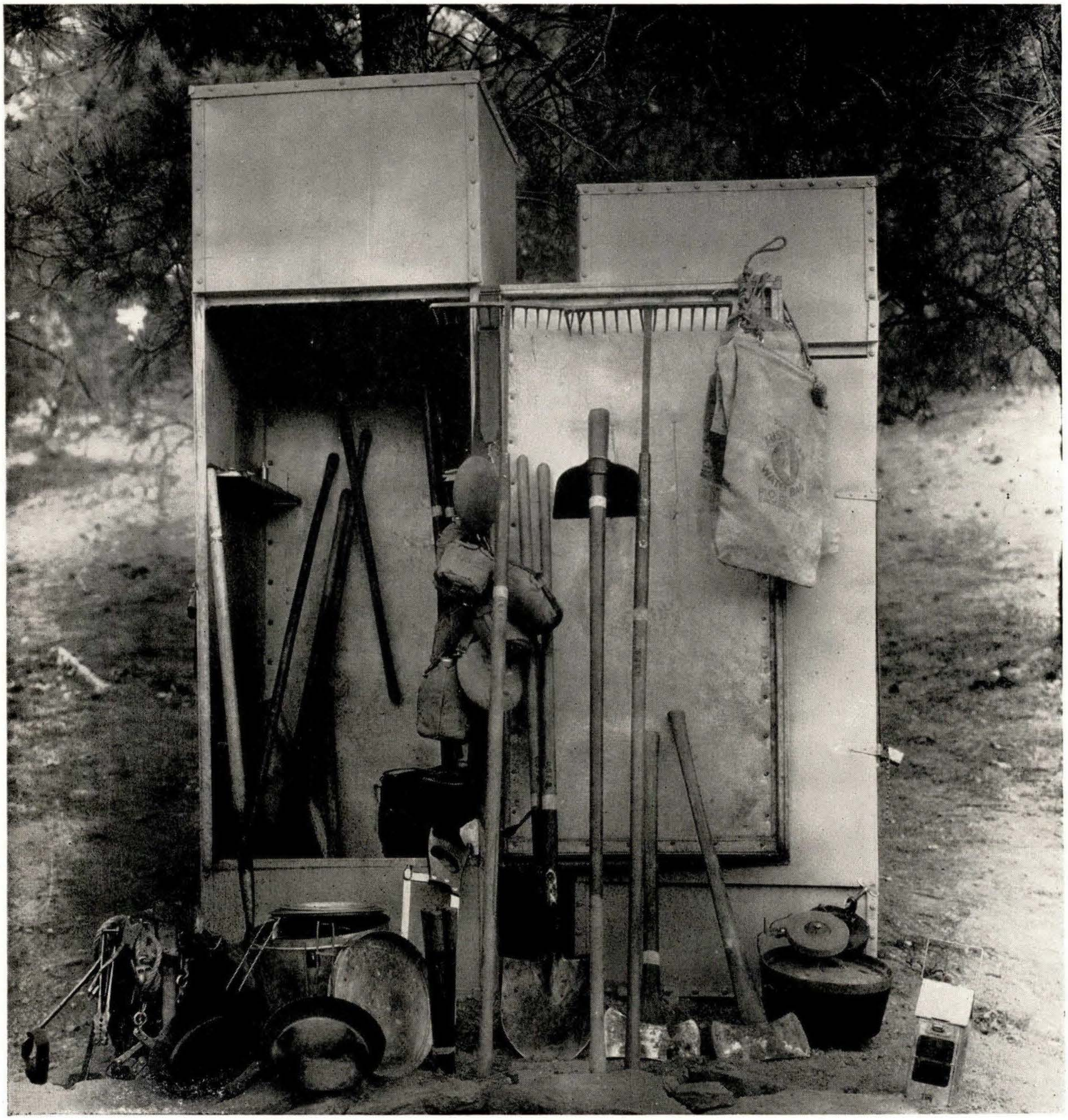


FIGURE I–20.— Metal fire-tool box, 8- to 10-man.

Box, Fire-Tool, 8- to 10-man.—The box shown in figure I–21 is suitable for an 8-man fire-tool outfit. It is 16 inches wide, 16½ inches high, and 90 inches long, outside dimensions. It can be made from ¾-inch lumber, but ¾-inch waterproof plywood is better. The bottom of the box illustrated is made of cedar. Where plywood is used, reinforcing inside cleats are unnecessary. Regardless of the material used for the bottom, there should be 1 x 4-inch strips throughout its length at the outside edges to absorb wear when the box is dragged.

The corner reinforcing at each end of the box is made from a single piece of 18-gage iron 3 inches wide, cut and bent to form an angle around the box end, except at the top. Two U-straps of the same material extend across the bottom and up the sides. The reinforcing metal is attached with rivets, inserted from inside the box.

The handle at each end is made of ½-inch pipe, bent and flattened at the ends, and pivoted so that it drops down against the box when not in use. Square-head bolts are used as handle stops.

The box illustrated is made to accommodate a long saw. The same type of construction may be used for boxes of different dimensions—for larger or smaller tool outfits, or different kinds of tools. Cost, about $16.

Boxes, Fire-Tool, 6-, 12- and 25-man.—Standard 6-, 12- and 25-man tool boxes have been developed in Region 8 for general use. They are tightly constructed to keep out rain and dust and reduce to a minimum the fluctuation of interior moisture. In conditions of high humidity, tools rust quickly if not properly housed and maintained. These boxes have an overlapping and inset lid and are as nearly waterproof as they can be made without excessive expenditure.

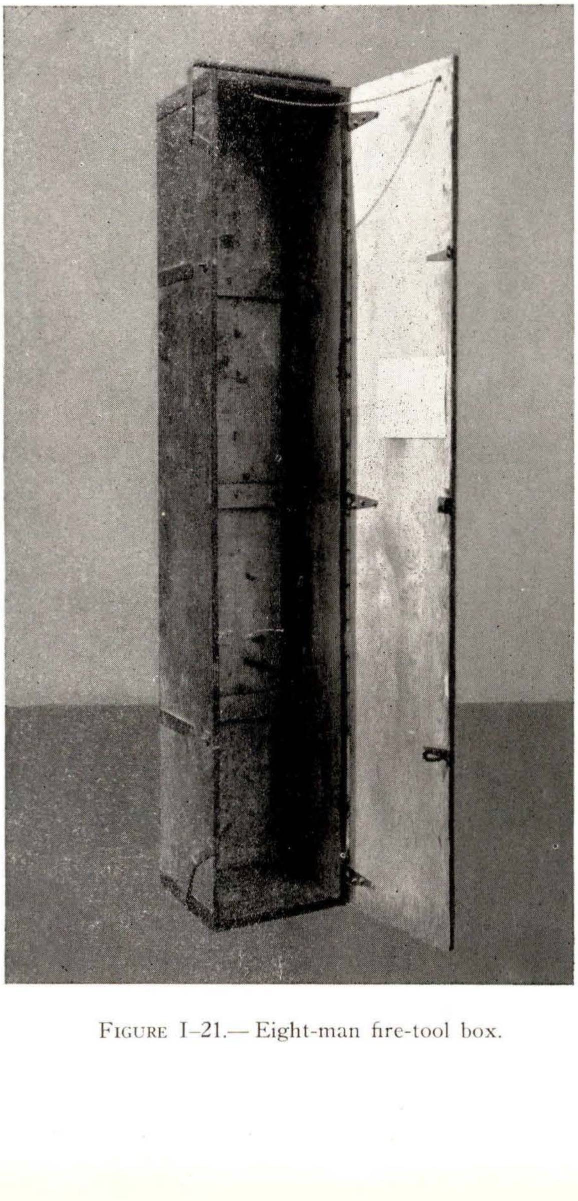


FIGURE I–21.— Eight-man fire-tool box.

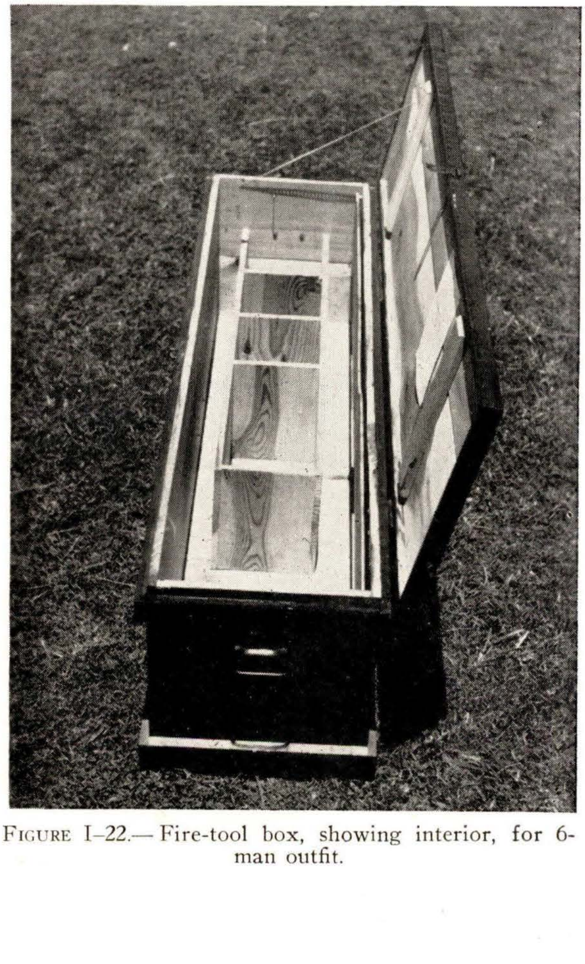


FIGURE I–22.— Fire-tool box, showing interior, for 6-man outfit.

The 6- and 12-man boxes are for use on pickups, with road crews, and at warden locations (fig. I–22). Two boxes, alike as to size and interior construction but with different partitioning (fig. I–23), are used for a 25-man outfit. They are designed to fit into a 1½-ton truck, as shown.

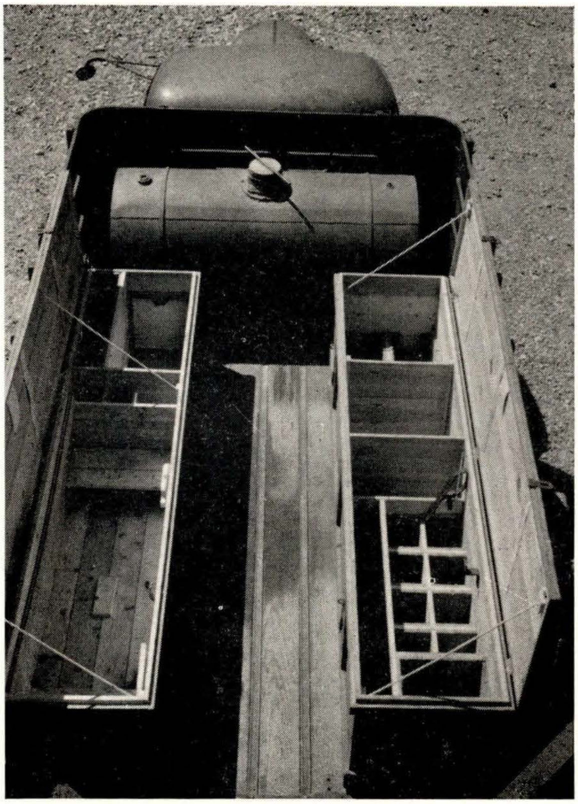


FIGURE I–23.—Two 12-man outfit boxes on 1½-ton truck.

Boxes, Ax.—Suitable boxes for transporting double-bit axes can be constructed of ¾-inch lumber. The ends should be bound with metal box strap.

Inside dimensions of box to hold 12 axes of any pattern: length 18 inches; width 8 inches, depth 5½ inches. Three top pieces, 3¾ inches wide are used, one at each end and one at the center. The center piece is hinged and secured with a hasp.

Inside dimensions of 6-ax box: Length 9½ inches; width 8½ inches; depth 6 inches. Top pieces, 4 inches wide, are used at the ends, one being hinged and secured with a hasp.

Box, Adz Hoe.—This box is suitable for 12 adz hoes, handled ready for use. It is constructed of 1-inch lumber, the ends being bound with box strap. Inside dimensions: Length 41 inches, width 16½ inches; depth 9 inches. (Fig. I–24.)

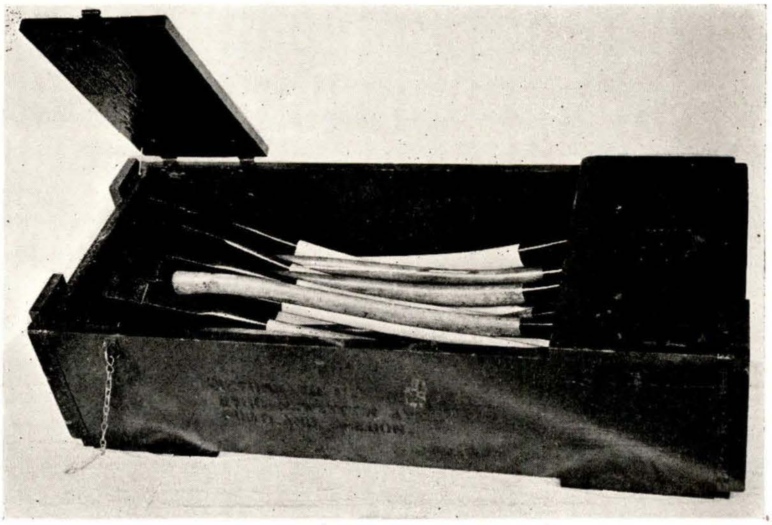


FIGURE I–24.—Adz hoe box.

Brackets, Ax and Shovel.—The ax and shovel brackets (fig. I–25) consist of four pieces and are constructed for mounting on any type of equipment. They will hold firmly in place without the aid of straps, either the No. 0 or No. 2 long-handled, round-pointed shovels, and any type of ax.

The shovel bracket is made of ⅜-inch round material, welded to a 4 x 5 x 3/16-inch plate, bent at the middle to a 60° angle. The ax bracket is fabricated from a piece of 16-gage sheet, 4 by 6 inches, bent so as to form a pocket approximately 4-3/4 x 3/4 x 4 inches. The backing strap is of 1-1/2 x 3/16-inch material, bent as illustrated. The clips are made from a continuous piece of 1-1/2 x 3/16-inch spring steel formed to fit the handles.

Weight of the four pieces is 4 pounds. Cost of the completed set is approximately $3 when produced in quantities of 50.

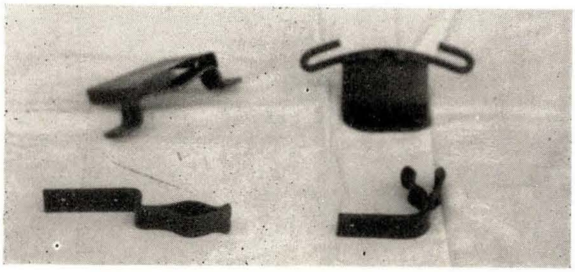
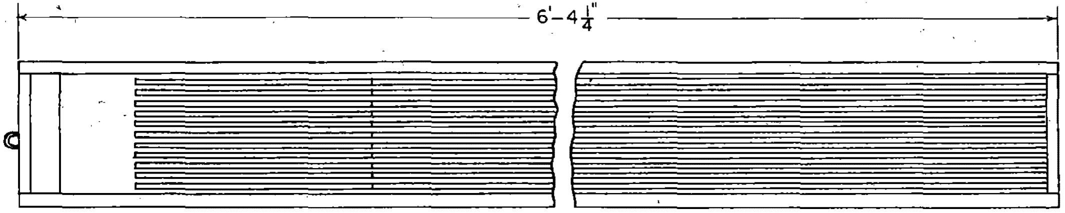
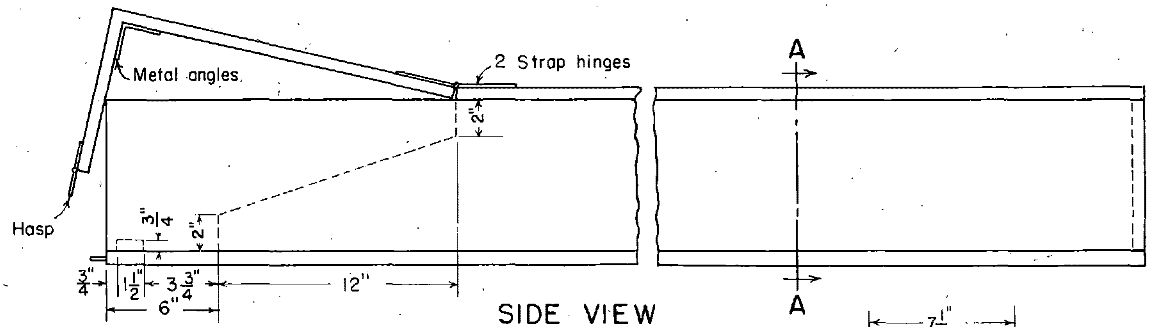


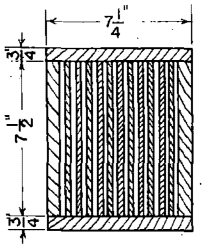
FIGURE I–25.— Ax and shovel brackets.



PLAN VIEW WITH TOP BOARD REMOVED


Metal angles
2 Strap hinges
2"
Hasp
$\frac{3}{4}$
2"
A
A
$\frac{3}{4}$"
1$\frac{1}{2}$"
3$\frac{3}{4}$"
12"
6"

SIDE VIEW


7$\frac{1}{4}$"
$\frac{3}{4}$
7$\frac{1}{2}$"
$\frac{3}{4}$

SECTION A-A

NOTES: This box is for 6' saws, lengthen as necessary for other saws.

Saws slide in teeth up.

Similar boxes may be constructed for different numbers of saws, for 2, 4, and 8 saws the box widths would be approximately 2$\frac{1}{4}$", 3$\frac{1}{4}$", and 5$\frac{1}{4}$" respectivly.

BILL OF MATERIALS FOR 12 SAW BOX

4 Pc.	$\frac{3}{4}$" X 7$\frac{1}{2}$" X 6'-4$\frac{1}{4}$"
2 Pc.	$\frac{3}{4}$" X 6" X 7$\frac{1}{2}$"
11 Pc.	$\frac{1}{4}$" X 8" X 5'-10"
1 Pc.	$\frac{3}{4}$" X 1$\frac{1}{2}$" X 6"

2 Hinges, strap 6"
2 Metal angles 3"X 3"
1 Hasp
About 70 – 8d. nails
Dimensions are for finished lumber.

CONSTRUCTION SPECIFICATIONS

12 Compartments $\frac{1}{4}$"
11 Partitions $\frac{1}{4}$"

Partitions may be rabbited into top and bottom or spaced with $\frac{1}{4}$" X $\frac{1}{4}$" strips.

If plywood is used specify water proof glue.

CROSSCUT SAW BOX

L.G.G.–U.S.F.S., W.O., 1947

SECTION J

FIRE LINE POWER EQUIPMENT

USE OF MECHANIZED EQUIPMENT

The use of mechanized equipment in control line construction has advanced to the stage where a study of its selection and application assumes major importance. Use, while diversified, has been uncontrolled from the test standpoint, so that unfortunately definite conclusions as to performance, selection, and application are lacking.

Men in certain areas favor crawler-type tractors, while others prefer the farm or wheeled units. Many believe that the best function of the tractor is to push a dozer blade, but opinions vary as to the use of the "V" blade, bulldozer, or angle-dozer. There are advocates of light plows and heavy plows, pulled plows and pushed plows, but even here there is divergence of opinion on plow design.

Most of these individually favored methods apply on the particular terrain where the equipment is used. Machines selected for line building range from the hand-propelled trencher to the 20-ton tractor-trailbuilder, for use on terrain varying from the flat coastal plains to steep mountain slopes, and in cover from grassy fuels to heavy brush and young trees. Under all of these conditions there can be cited actual instances where the use of machinery increased efficiency far beyond that which could have been attained by manpower alone. Yet, a criterion is lacking, and questions involving whether plows or blades should be used and what sizes will give best results under given conditions are highly controversial.

CHOICE OF SUITABLE UNITS

Determination of the best unit is a problem calling for broad analysis, including at least the following steps:

1. Accept as a principle that there are no all-purpose units. Different localities and cover types require different designs.

2. Limit consideration to areas where factors can reasonably be expected to travel cross country. Analyze an area to determine the characteristics of its (*a*) soil—clay, loam, sand, muck, etc.—and quantity and type of rock, boulders, and gravel present; (*b*) fuel—kinds of fuel present—grass, needles, leaves, few or many down logs, duff, depth of humus, density of brush and reproduction; (*c*) probable fire behavior—flash, fast, moderate or slow spread, and width and depth of control lines required to prevent breakover; (*d*) accessibility—frequency and adequacy of roads for transporting equipment.

3. Make close estimates of elapsed travel time required to get units onto the fire line in strategic position and compare with probable rate of spread of the fire. What perimeter will the fire have attained upon arrival of the unit or units?

As an example, head fires in Coastal Plain fuels frequently advance as rapidly as one mile per hour. Under these conditions, elapsed time until first attack is a major factor in suppression results. Within certain limits, elapsed time for transporting equipment can be considered as proportional to the load to be carried. A light-weight tractor on a 1½-ton stakeside truck will arrive at the scene of action long before a 20-ton semitrailer transport with a 20-ton tractor. It naturally follows that light machinery which can be quickly transported should be considered before trying out the heavier classes.

4. Calculate, through test or reasonable expectation, the rate at which the machine under consideration will construct satisfactory line in the area in question.

Unfortunately there are not sufficient data available to establish performance for the various types of line-building machinery. General performance of a machine is not necessarily a function of power, but appears to be more closely related to weight distribution and dimension. Light-weight narrow-tread tractors are dangerous on side slopes and steep pitches. A small obstacle may overturn the unit with little warning. Small tractors of conventional design can rarely be expected to climb grades in excess of 40 percent. A bog or loose soil condition may stop conventional small tractors where the heavier units may not even falter. Heavy equipment likewise has its limitations. Field experience shows a pronounced tendency to operate near the critical performance point. A tractor that can be operated safely on a 30 percent slope is soon being tried on grades near 35 percent. Shortly thereafter the demand is for a unit capable of performing on 45 percent slopes. This cycle has sometimes progressed to unprofitable extremes.

Where character of the terrain is known to be fairly uniform, it is possible, after limited testing, to establish a performance criterion. But where mountainous areas with widely varying characteristics of topography and cover are being considered, a careful survey and probably extensive tests will be necessary in order to assure dependable decisions.

5. Evaluate machines in terms of comparable output by crews with hand tools. Only in isolated cases has this been done systematically. First, compute the cost of selected case fires which have been suppressed with manpower without machines. Here the best unit of measure is the famil-

iar rate formula expressed in number of chains of held line per man-hour. Then estimate the cost of suppressing these same fires with tractor-plows or tractor-dozers supported by the smaller crews of men required. It is realized that accurate cost comparisons can evolve only from using machinery and man-power crews on fires burning under similar conditions, but the suggested comparisons will aid greatly in determining the advisability of employing machines.

6. Determine which method of suppression will result in earliest control and reduce the time of exposure to rising or shifting winds. Under certain conditions, for example, a plow will build line as fast as a crew of 20 men equipped with hand tools; or a large tractor-dozer will exceed the rate of 150 men. If the time required to alert, gather, equip, and transport the men is greater than the time required to start the attack with machines, the fire will have spread and more time will be necessary to build the added length of line. Also, a matter of major importance is the possibility of spot fires induced by enlarging fire area and accelerating air currents. Furthermore, in making these comparisons due weight should be given to the dwindling effectiveness of hand labor through human fatigue.

COORDINATION OF MEN AND MACHINES

The above discussion of the machine vs. manpower has been confined largely to comparisons on a single fire. However, on districts where several fires may be expected in one day, the value of the machine is increased. Strategic location of stand-by units may, in effect, introduce combination possibilities which offer several advantages, particularly where adequate supplies of labor are not available.

The ideal suppression crew will combine hand labor and machinery. A well coordinated organization with its force balanced as between the two elements is, of course, the goal. The common tendency as machinery is introduced is to rely more and more on equipment and to slight the ever important hand-labor. This can progress, particularly where initial ventures have been successful, to a stage where periodic reviews of the fire organization are necessary to prevent it from becoming overly equipment conscious. For the present at least, fire-line machinery cannot be substituted entirely for the versatility and dependability of a well-trained crew with hand tools, and constant vigilance is necessary to hold the use of machinery to the degree consistent with need and economy.

REGIONAL EXAMPLES

In the various timbered regions of the country progress in the use of mechanized equipment has varied greatly. Fire control managers in the Pacific Coast areas and the pine areas of the Southeast are now making fuller use of it. The methods and equipment briefly described in the regional examples illustrate application to local conditions:

Pacific Coast Areas

Tractors—Angle-Dozer Equipped.—Medium-size units (35 to 50 hp.) are used in brush, in small reproduction, or where material to be moved is small. They can generally be operated on grades and side slopes up to 40 percent. Performance, however, will be governed by the terrain.

Heavy units (75 to 100 hp.) are used in heavy fuels such as lodgepole thickets, blowdowns, thick pole-size timber, and dense brush, and where terrain requires maximum performance ability. Grade ability of these units is generally in excess of 50 percent, but is dependent on local conditions.

Pacific Northwest

Plows.—The small Wescoatt plow pulled by a light tractor (see fig. J–3, and description) is popular in areas where fuels are not heavy, because the complete outfit can be transported in a 1½-ton stakeside truck. It operates safely on a 50 percent side slope if the tractor is wide gage (50 inches), with low center of gravity. Since the plow is a wheelless type, with a rounded point, it can be used on any terrain within the limitations of a light, stable tractor, and in rocky soil. Tractors with adequate drawbar pull and stability, and weighing slightly over 2 tons, are available.

Plow, Wescoatt.—This is a middle-buster plow which needs no carriage. A sturdy hitch provides for vertical and horizontal motion and is so designed that it may be adapted to any make of tractor. The plow can be lifted with a hand winch and cable, as shown in figure J–1, a power winch, or hydraulically. Whatever method is used, the plow should be locked in place when lifted, so that it will not swing from side to side in traveling along a road or cross country.

The plow illustrated weighs 465 pounds, with hitch and cable; tripod and hand winch weigh 60 pounds. The cost, complete, is approximately $300. Dimensions: From front end of beam to rear of moldboards, 72 inches; from plow point to midpoint between shares at rear, 22 inches; between shares at rear, 27 inches; between moldboards at rear, 31 inches.

The size described is satisfactory for a tractor with drawbar pull of 4,000 pounds or more. It makes a flat-bottom trench about 2 inches deep and 40 to 50 inches wide, including roll. The width of roll depends on soil and cover conditions. Under favorable conditions, the plow will stay in the ground without weighting, but bars are installed between the moldboards, and a handle on the beam, so that a man can ride the plow safely if necessary. Weights could also be carried on the tractor and attached to the bars between the moldboards where needed to keep the plow in the ground.

A middle-weight plow is being developed for sandy soils with cover too dense for the Ranger's Pal, but not so dense as to require a heavy plow. It will be simply a larger model of the Ranger's Pal.

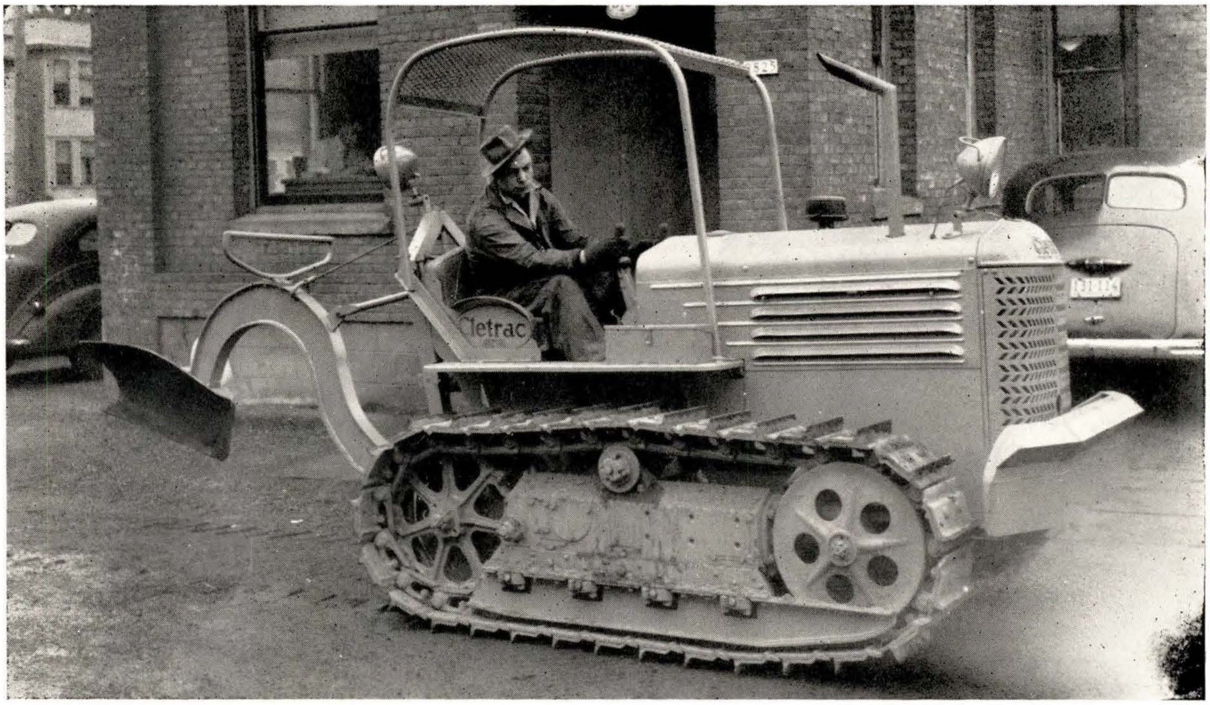


FIGURE J-1.— Wescoatt plow, locked in position for traveling.

Coastal Plains, Piedmont, and Mountains of the Southeast

Three types of plows have been designed for use in these areas. A heavy disc plow, such as the Mathis (figs. J-7 and J-8) is needed in the dense, luxuriant stands of reproduction and brush occurring in the Coastal Plain. The light Ranger's Pal (figs. J-2 and J-3) answers the need in the grassy flatwoods with minimum brush. Neither of these plows can be used in stony soil, but the Ranger's Pal is suitable for Piedmont areas that are free from rock and where the terrain is not too steep.

The middle-buster plow (figs. J-4 and J-5) is similar to the Wescoatt plow used in the Pacific Northwest. It was designed particularly for mountainous areas with rocky soil, but it is also suitable in the Piedmont, although the Ranger's Pal does a better job under conditions to which it is suited.

Plow, Ranger's Pal.—The "Ranger's Pal" (figs. J-2 and J-3) was designed and constructed in Region 8 to meet the need for light, fast-moving first-attack equipment in the homogeneous soils of the Coastal Plain. It works best in the grassy flatwoods of the longleaf belt, where gallberry, titi, and palmetto brush are at minimum growth, and is especially suited to the light-to-medium grassy "roughs" of Texas, Louisiana, Mississippi, and

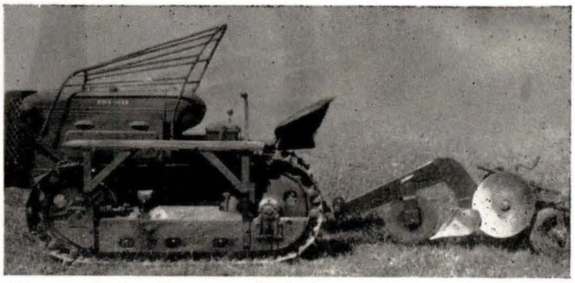


FIGURE J-2.— Ranger's Pal plow, raised ready for trailing.

Alabama. It will not work successfully in rocky soils.

Attached to a Cletrac, Model HG, or a Clarkair tractor, the plow makes a flat-bottom trench 28 inches wide and 2 to 4 inches deep at speeds in excess of 2 miles per hour. With side slopes and overthrow, the over-all width of effective line is approximately 48 inches.

Over-all length of plow, 7 feet; width 28 inches. Weight 465 pounds. Total weight of outfit, with Cletrac tractor, Model HG, 3,785 pounds. Approximate cost of plow, $225.

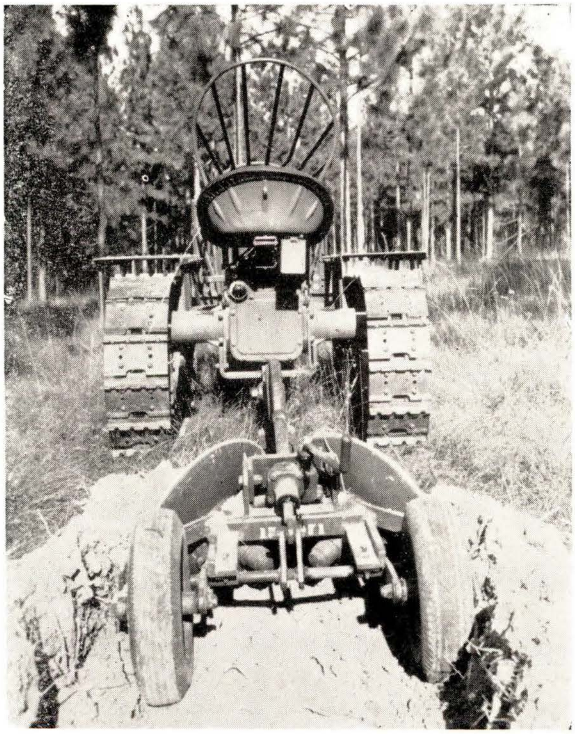


FIGURE J-3.— Ranger's Pal plow in operation, showing trench it builds.

Plow, Middle-Buster.—The plow shown in figures J-4 and J-5 was designed in Region 8 for fire control line trenching in mountain regions with rocky soil. It is not as effective as a disc plow in the Coastal Plain forests. It makes a trench 25 to 30 inches wide. The plow point has a root-ripping action, and the wings spread the dirt to the sides.

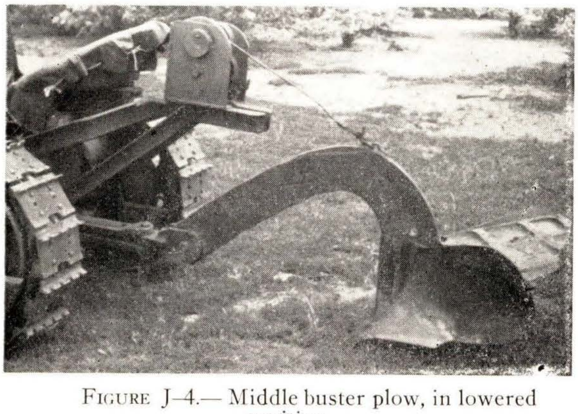


FIGURE J-4.— Middle buster plow, in lowered position.

As used in Region 8, this plow is drawn by a Cletrac tractor, Model HG, but it could be adapted to other makes and sizes of tractors. It is attached to the tractor drawbar by a clevis and pin, and is raised and lowered by a hand winch, as shown. Weight of plow, approximately 300 pounds; weight of tractor and plow complete, about 3,650 pounds. Heavy pieces of iron are carried on the tractor when the ground dries out and becomes harder, so they can be placed between the wings if additional weight is needed to keep the plow in the ground. The complete outfit can be transported easily in a 1½-ton truck.

Cost of plow, complete with frame and winch approximately $125. The only repair necessary on one such plow after use on 100 fires was a new winch cable.

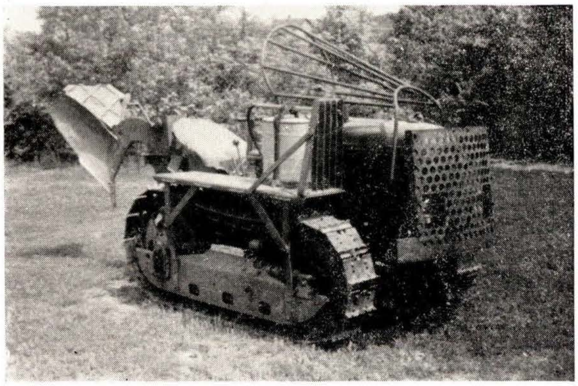


FIGURE J-5.— Middle buster plow, raised and locked in place. Note scrap iron used to weight plow.

Plow, Tractor, Push Type.—This plow (fig. J-6) is a middle-buster attached to the front of a 20-horsepower-class, crawler-type tractor, and supported by a swinging beam projecting from beneath the tractor and framework. There is a worm gear and take-up shaft, operated from the driver's platform, from which a cable is extended to the plow for raising and lowering. The plow has a forward projecting beam, on which is attached an adjustable depth gage or shoe to regulate depth of trench.

This unit is very effective in the loblolly-shortleaf-hardwoods type of the South. It will construct a 4-foot fire line at the rate of 1 mile an hour, and has been used successfully on slopes up to 25 percent, but is not very effective in rough country.

Gross weight of the outfit, about 9,000 pounds; cost of tractor $2,200; and cost of mounting plow $500. Operating life, 8 years; operation cost, $1.25 per hour.

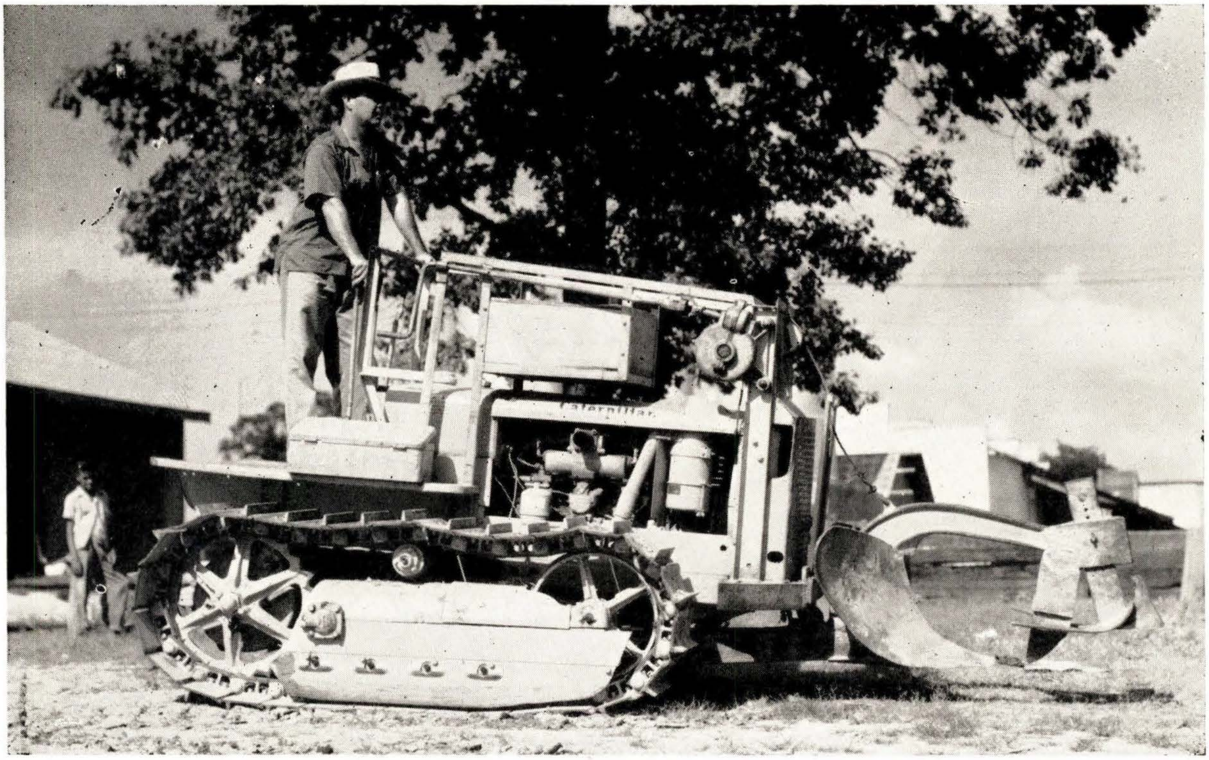


FIGURE J–6.— Push-type plow developed by Arkansas State Forest Service.

Plow, Mathis 2-Disc.—The Mathis plow (figs. J–7 and J–8) has two manually-operated raising and lowering jacks. The working parts are attached to the central beam and frame as follows: The rolling coulter, which cuts heavy roots and woody debris, is followed by the middle-buster plow and the two rolling discs. The coulter is so arranged that it will cut an inch deeper than the middle-buster.

Line is usually constructed with the plow set about 1½ to 3 inches in depth. Width of the line is 48 inches, exclusive of the berm or roll. Shallow plowing allows for greater speed in construction. However, the depth must be sufficient to allow a clean roll of the turf to both right and left.

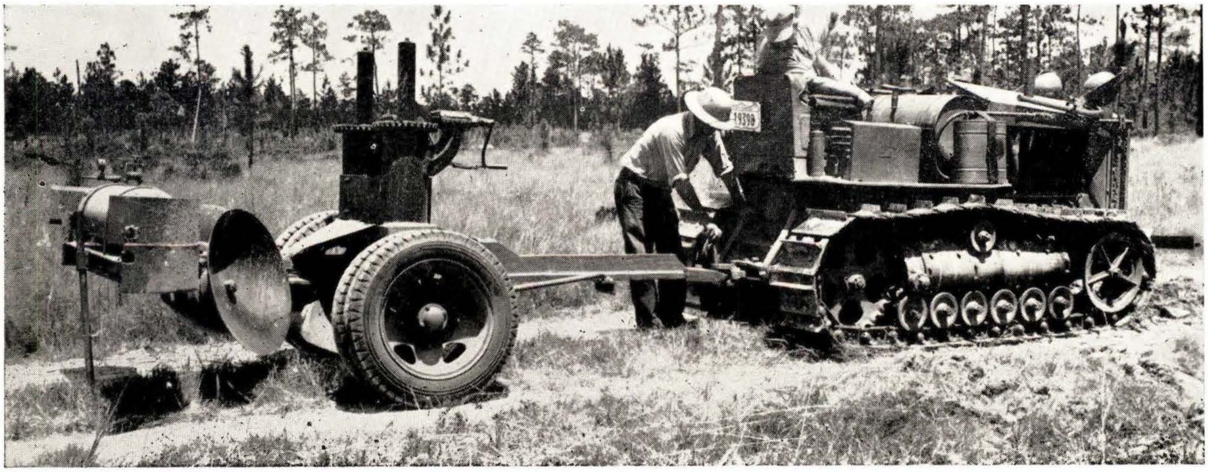


FIGURE J–7.— Mathis 2-disc plow in raised position.

The Mathis plow was designed to overcome the difficulties of line construction in dense stands of reproduction and in those areas where gallberry, palmetto, and titi brush make their maximum growth, as in the flatwoods of Florida. On the coastal plains of South Carolina, North Carolina, and Florida, this plow does a remarkably good job when drawn by a 35 or 25 size tractor, depending on condition of the rough. The smaller tractor is used in the lighter roughs of Mississippi and Louisiana with great success. The plow will not work satisfactorily in rocky soils. Plow and tractor are hauled to fires on a semi-trailer.

Weight of plow is approximately 3,000 pounds and cost about $545.

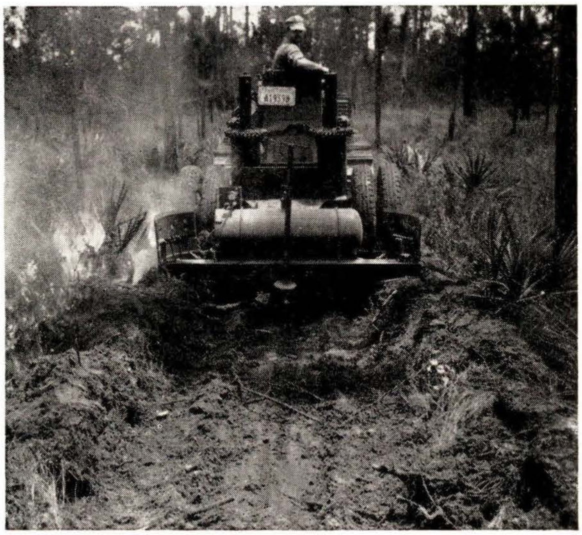


FIGURE J–8.—Mathis 2-disc plow in operation.

Michigan Department of Conservation

Plow, Walking, Tractor-drawn.—The Michigan Department of Conservation has developed a number of types of plows for use in forest-fire control. One of these is illustrated in figure J–9 and is identified as "Walking Plow, Model PWL–1, Type FC."

Essentially, the plow conforms to the general design of the usual horse-drawn walking plow, except for size and weight. Current models have shorter and heavier beams than the one illustrated; the beams are either reinforced with heavy hardwood cores, hickory or oak preferred, or the channels are completely boxed by welding flat sections to the upper and lower surfaces.

The machine can be operated with or without a plowman, because of a landshoe which keeps the plow upright when in use. Adjustment for different heights of tractor drawbar is provided on the headplate. The usual wheeled or crawler types of 20-horsepower tractors are used.

Rates of fire-line construction average 1½ to 2 miles per hour. Line averages up to 38 inches in width of bare dirt exposed; in very dry soils it may be wider.

This plow has proved satisfactory as a supplement to heavier sulky plows. It can be used in cramped quarters, where wheeled plows lack space for operation, and has been used successfully as replacement equipment or as new issue where machines must be gathered in quantity on fire location. Four plows can be loaded onto a 1½-ton truck and two units can be hauled by a light trailer or a pick-up truck.

In use, a draw chain rather than direct attachment to the drawbar of the tractor is recommended. This takes care of uneven surface conditions and contributes to more uniform operation of the plow. The chain should be at least 2 feet long and provided with proper end rings. It should preferably be 4 feet long, so that it may be doubled.

Dimensions and weight: Length, 6 feet 6 inches; width, 3 feet 4 inches; height, 2 feet 2 inches; weight, 600 lbs. Cost complete averages $125 when built in lots of 10.

Cost of maintenance is limited to replacement of beams and occasional repair of moldboards and shares. Barring accident, these will last the normal length of the fire season. Breakage and accident can be reduced to a minimum if tractor operators will take time to back the plow out of the furrow before making sharp turns, which tend to place undue strain on beam members. This is correct usage of any plow in fire-line building and the common practice of skilled operators.

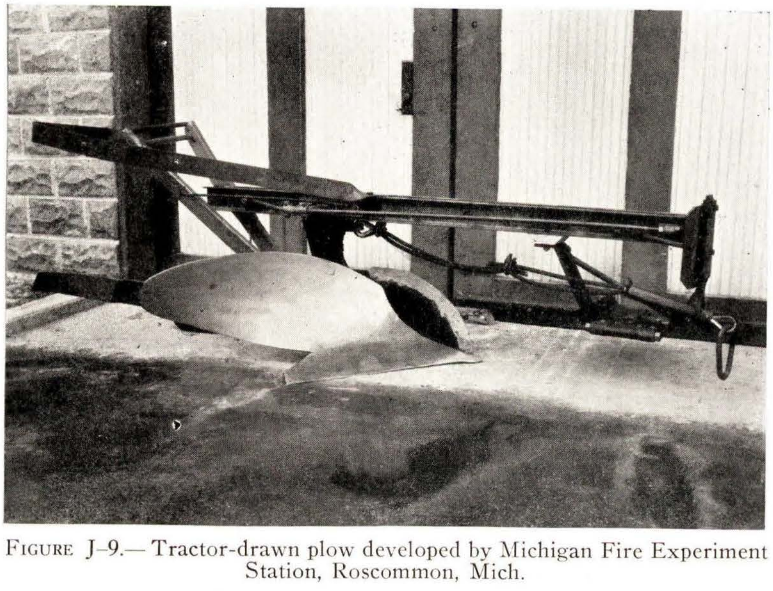


FIGURE J–9.—Tractor-drawn plow developed by Michigan Fire Experiment Station, Roscommon, Mich.

Plow, Horse-drawn. — Horse-drawn plows are still used to some extent for fire-line trenching where topography, soil, and cover conditions make their use practicable. Figure J-10 shows a reversible sidehill plow, which has proved suitable for this work. Its design and construction are such that it can readily be disassembled for animal packing.

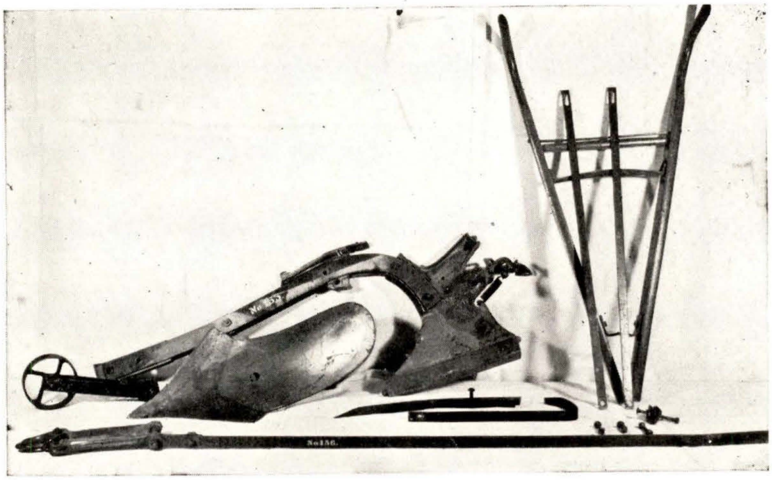


FIGURE J-10.—Horse-drawn plow, assembled and cargoed for packing.

Mat, Chain and Asbestos

This mat (fig. J-11) is used to break up and smother fire as it is dragged along by truck or horsepower. It consists of a chain mesh rectangular in shape, not less than 80 by 100 inches, constructed of round, welded rings made of 3/16-inch round steel stock, 1½ inches inside diameter, and an asbestos mat of wire-inserted cloth weighing about 4 pounds per square yard. Asbestos and chains are fastened together with heavy metal fasteners.

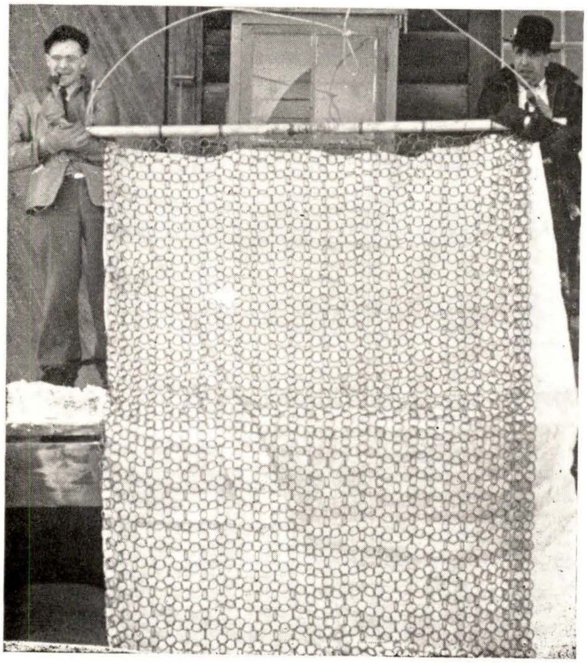


FIGURE J-11.—Chain and asbestos mat.

Use of the mat is confined largely to areas of grassland and light shrubs in flat or rolling country. In general, it can be used in areas which can be covered by a light truck. It cannot be used over rough terrain or in heavy brush.

The mats are usually attached to pipes extended from the side of a light truck, which is driven parallel to the fire dragging the mats over the fire line (fig. J-12). One trip with two mats usually extinguishes a grass fire, but in some cases a second trip is required. Best results are obtained at a speed of 5 miles per hour. Two saddle horses may be used to drag a mat where a truck is not available.

Under favorable conditions the truck and mats can do the work of 50 men using hand tools.

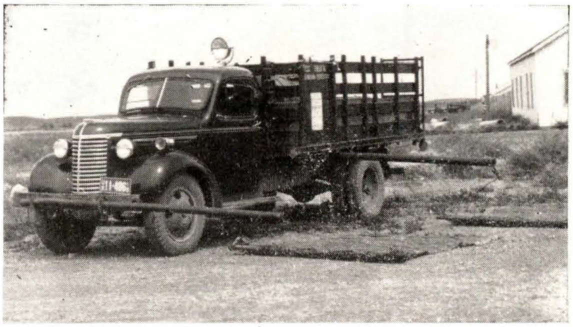


FIGURE J-12.—Fire mat attached to truck ready for use.

Portable Power Saws

Power chain saws are being used in the lumber industry to a considerable extent. While felling and bucking in connection with fire control line construction and the mop-up of fire areas are ordinarily done under more difficult conditions than are found in logging operations, power saws can be used effectively for this work in certain locations.

Rapid development of power saws has been due largely to the increasing scarcity of expert hand fallers in localities where the timber is large. Since this situation is not likely to change, fire control managers will have to depend more and more on power saws in fire suppression. Such equipment will be of greatest use in heavy western timber, where there are large areas of old burns and stands of more or less defective green timber. Control-line construction in such areas usually includes the felling of numerous large snags and defective green trees, and often this must be done with all possible speed. Where it appears that the number of expert hand fallers that may be required will not be available, plans should provide for power felling, supplemented by hand felling in areas where the topography is such that the use of power equipment is impracticable.

Since effective work with power saws requires thorough training of operators, it is desirable to assign the available equipment to organized suppression crews employed throughout the fire season. The necessary training and practice can then be accomplished early in the season, so the crews will be ready to perform their job with maximum speed and efficiency.

Electric-powered Saws

Power chain saws adaptable to fire control work fall into two general classes: electric-powered and gasoline-powered. An electric outfit consists of a generator, a control panel, conductor cable, and a motor-driven saw. The generator may be mounted on a tractor or truck and driven through a power take-off, or it may be mounted with a gasoline engine on a frame and moved in a truck or trailer, or on a sled. Two types of electric equipment have been developed so far: 180-cycle and 60-cycle. The 180-cycle machine was developed because of the need for minimum weight of the motor, which, in felling, must be supported by the operator until the saw is buried in the tree. Reduction in weight necessarily requires increase in speed and reduction in size of parts. For this reason it must be expected that maintenance cost for 180-cycle equip-

(Continued on Page J-9)

ment will be higher than for 60-cycle or 120-cycle equipment.

Figure J–13 shows a 180-cycle outfit mounted on a small tractor which weighs approximately 4,200 pounds. The generator, 5-foot saw, 100 feet of 6-conductor cable, 500 feet of 3-conductor cable, control panel, and switch box weigh approximately 730 pounds. An outfit of this kind can be transported in a 1½-ton truck.

Figure J–14 shows a similar generator and saw

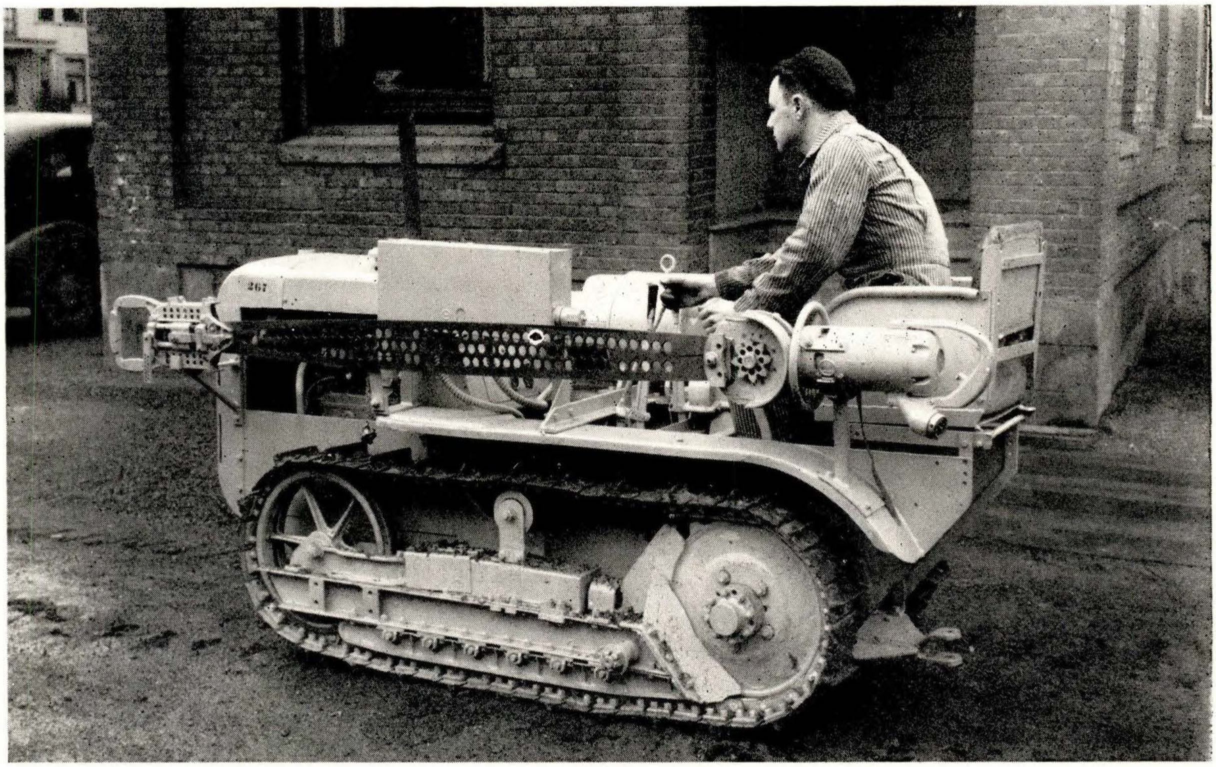


FIGURE J–13.— Electric saw outfit, mounted on small tractor.

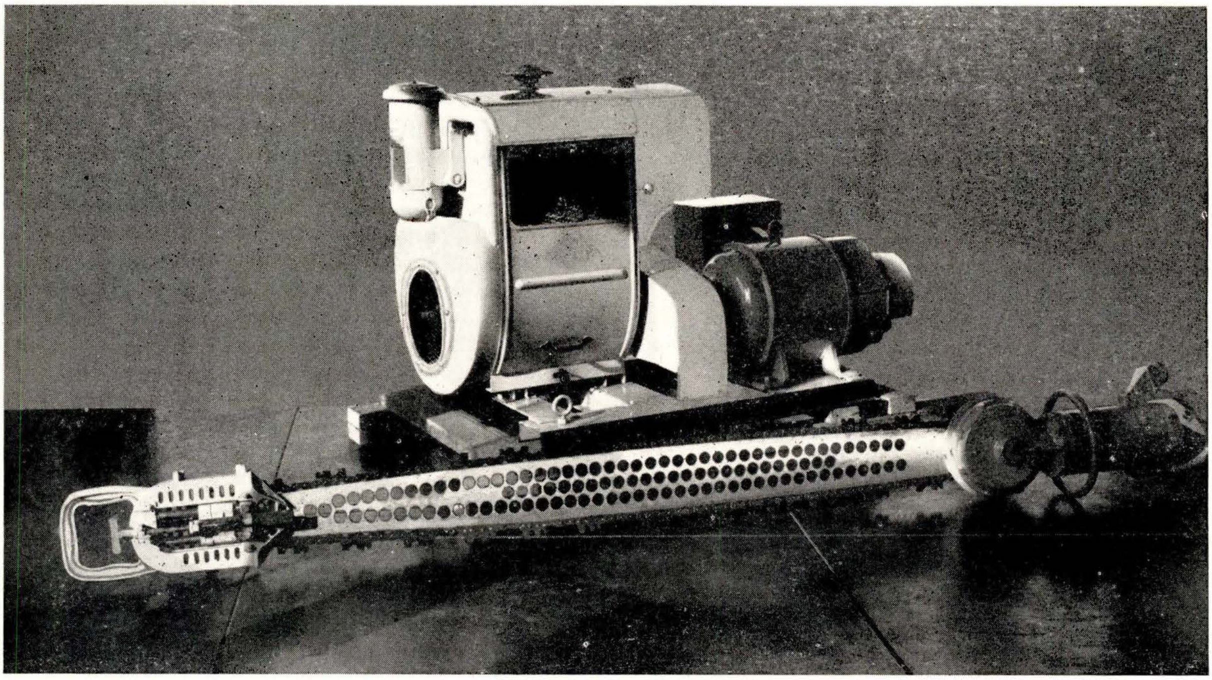


FIGURE J–14.— Electric saw outfit, with sled-mounted engine and generator.

mounted with a 25-horsepower air-cooled engine for transporting in a light truck, on a trailer or on a sled. The weight of this outfit is approximately 1,080 pounds. Sled-mounted outfits have been used in the lumber industry with an engine large enough to drive two generators.

The complete outfit for tractor mounting as described, with 500 feet of 3-conductor cable, costs approximately $1,450. Three-conductor cable costs 50 cents per foot. The outfit with 25-horsepower engine, mounted on a frame ready for operation, costs approximately $1,910. These prices are f.o.b. factory.

Experiments with electric saws in fire suppression have not progressed far enough to determine the most practicable type of mounting. Probably it will vary with ground conditions. The use of these saws will be limited to areas within about 1,000 feet of roads and areas where it is practicable to use a tractor either to carry and operate the saw or to pull a sled or trailer on which the equipment is mounted. In any case a truck or tractor will be needed with the outfit. Because of this fact and the high cost of the equipment, its usefulness and limitations in the locality where it will be used need careful consideration before the investment is made.

Gasoline-powered saws

There are several kinds of chain saws on the market which are powered with gasoline engines. The engines vary in design. Some have one cylinder, others two. Some of the two-cylinder type are upright, alternate-firing design, while others have opposed cylinders firing simultaneously. All are air-cooled and operate at high speed on the two-stroke cycle principle, because of the necessity for minimum weight and ample power. Cutting blades up to 4 feet in length can be driven successfully with engines of 5- or 6-horsepower, but for blades 5 feet or more in length 9- to 12-horsepower is needed.

The 4-foot saws with small engines weigh approximately 90 pounds complete, while the longer saws with more power weigh 110 pounds or more. The smaller saws cost about $650 and the larger ones about $750. One-man saws, with short blade and weighing about 40 pounds, are also available.

The gasoline-powered saws now in use have cutting chains similar in design. It is probable that improvements in chain design will be made. The Forest Service has developed a radically different design, which is still in the experimental stage. There will also undoubtedly be rapid improvement in gasoline engines, and the use of lighter metals, such as magnesium, may permit reduction of weight in proportion to power. One thing that is badly needed is standardization of cutting chain grooves to permit interchanging cutting chains, and protection agencies should unite in urging this improvement upon the manufacturers.

It is not practicable to include in this handbook the details of construction for various makes of saws. These can, of course, be obtained from manufacturers. Some representative types are shown in figures J–15, J–16, and J–17.

Gasoline-powered saws are suitable for use under much more varied conditions than electric-powered saws. Their weight is low enough that they can, if necessary, be animal-packed or dropped from airplanes, and they can be carried and used in relatively rough terrain. The shorter saws are particularly adaptable to the more remote and the rougher areas, provided the trees are not too large.

Saws powered with gasoline engines are less safe to operate than the electric type and operating difficulties are greater. However, improvements in magnetos, clutches, and starting mechanisms have already done much to overcome the major mechanical weaknesses of the earlier models.

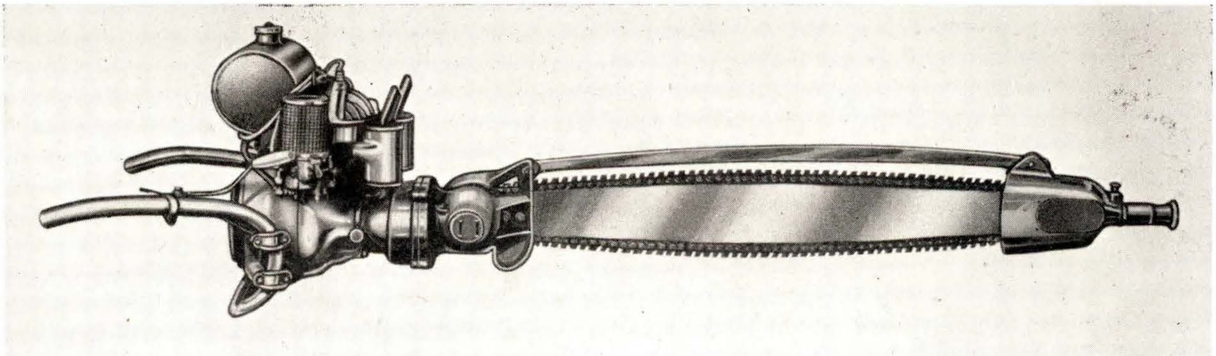


FIGURE J–15.— Gasoline saw with one-cylinder engine.

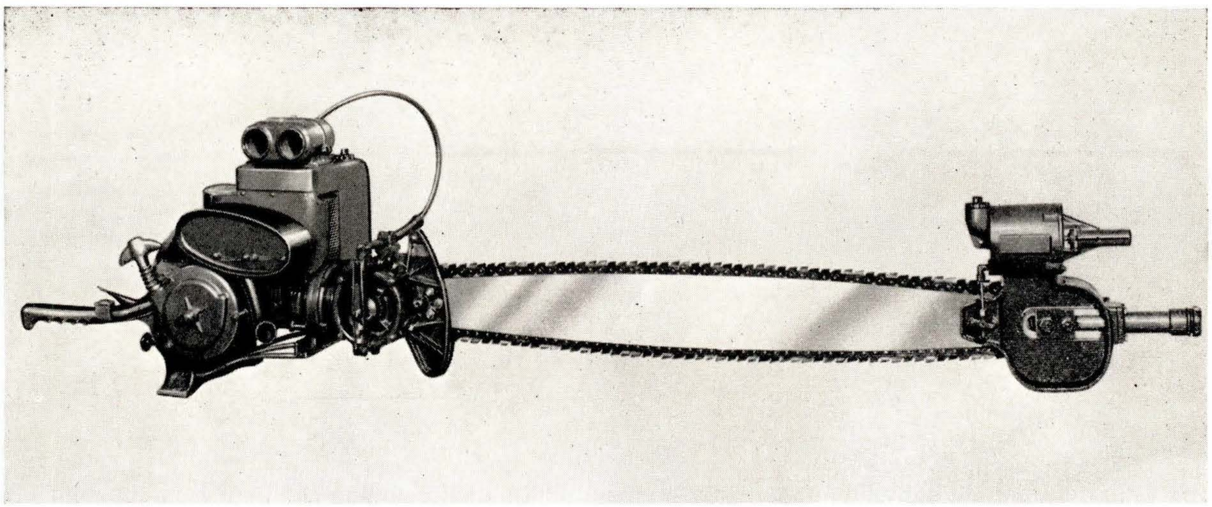


FIGURE J–16.—Gasoline saw with two-cylinder upright engine.

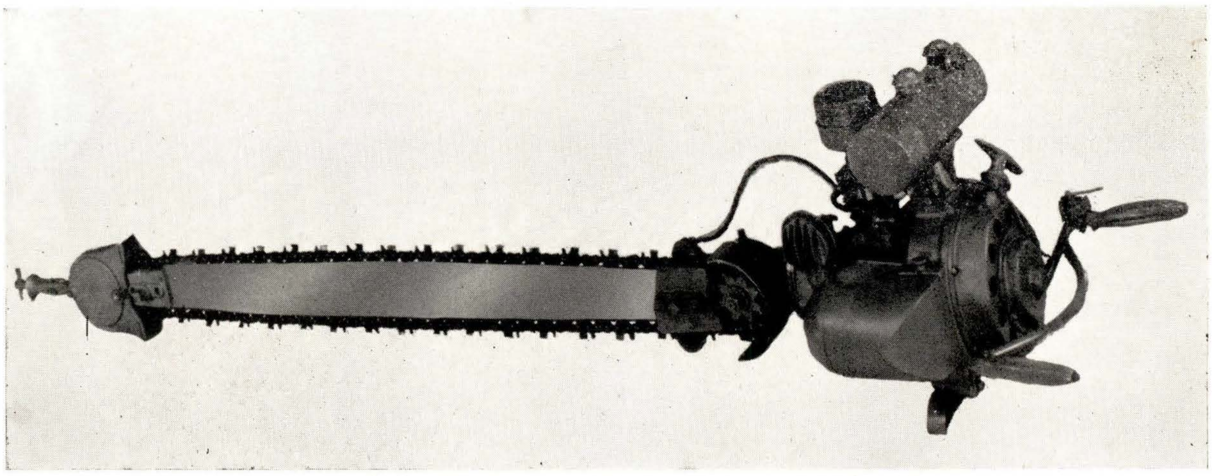


FIGURE J–17.—Gasoline saw with two-cylinder opposed engine.

SECTION K

PUMPING EQUIPMENT

General Discussion

Pump Classes

Pumping equipment is divided into three classes: Back-pack units, portable-power units, and pumps which are used in combination with trucks or cars. The back-pack is one unit of regular line tools and is used universally to knock down running fires, to aid in holding backfire, and in mop-up. Portable pumps are complete pump units which can be lifted and carried by hand or back-packed for considerable distances over various types of terrain and cover. They are seldom used to control a fire, but rather to deliver large quantities of water which aid in quick mop-up. There are two principal types, centrifugal and rotary. Weight limits vary from 75 to 200 pounds. Pumps which are used in combination with cars or trucks vary in type and design from the light fan-belt-driven pumps to the heavy units capable of delivering 500 gallons or more per minute. Many of these units aid in control as well as in mop-up.

ADMINISTRATIVE CONSIDERATIONS IN MAKING PUMP PURCHASES

Back-Pack Pumps

The purchase of back-pack pumps should be limited only to consideration of their proper proportion in comparison with other line tools used by fire-fighting crews under local conditions.

Portable Power Pumps

Is It Needed?—Has past fire occurrence been far from passable roads? Has water supply been adequate for portable pumps so they might have been used effectively? Would earlier purchase and effective use have decreased burned acreage and suppression costs? Will special risks or hazards justify the purchase?

Weight.—Is lightest possible weight a major factor? Ordinarily where portable power pumps must be man-packed for long distances, lightest weight is essential and should be the first consideration. This decision once made would limit a choice to two-cycle pumps weighing not over 75 pounds. Where carries are not so long, the more dependable four-cycle pumps, using straight gasoline rather than a gas-oil mixture for fuel, may be considered. The lighter types of four-cycle pumps weigh slightly more than 100 pounds. Heavier models weigh up to 200 pounds. Length of carry and terrain should guide a decision on weight.

Pressure.—Pump pressure becomes a major consideration where terrain is rough or mountainous. Pumps used in mountain country should be able to produce maximum pressures of 175 to 200 pounds. Pumps producing pressures of 100 to 125 pounds are satisfactory on level or near-level terrain.

Nozzle pressure.—Ordinarily a ¼-inch nozzle is used with a 1½-inch hose line. With 50 pounds nozzle pressure, delivery is approximately 12 gallons per minute, which is considered adequate for most suppression needs.

Ease of starting.—Under usual field conditions, a four-cycle air- or water-cooled motor is easier to start than a two-cycle motor.

Dependability. — Where two-cycle pumps are used, an employee experienced in their operation should be immediately available. The four-cycle pump needs less attention during operation.

Abrasives in water.—Where water is muddy or full of sand or other abrasive material, the centrifugal pump should be considered, since rotary pump parts wear fast under such conditions and require repair at short intervals. However, emergency situations may justify the use of rotary pumps under such conditions.

Original and repair costs.—The original and repair costs on the light-weight two-cycle portable pumps are usually higher than on the heavier types.

Car or Truck Pump Units

Is it needed?—Do a sufficient number of fires start on or near passable roads to justify the purchase? Uses would include direct attack or mop-up on fires where the hose line can reach them, to fill back-pack pumps and avoid long carries, and to serve as first relay where used in connection with portable pumpers and sufficient water is available.

Permanently attached, demountable, and slip-on units.—An administrative choice should be made between units permanently attached to a particular vehicle, a demountable unit which may be mounted on a truck of similar design, or a slip-on unit.

The permanent unit is usually a complete fire truck, and in most cases power is supplied by the truck motor. Such units have some prevention value and are helpful in building morale within the organization. Less frequently, a small fan-belt-driven pump is permanently mounted on the engine of a pick-up used by patrolmen or snap crews.

The demountable unit is usually powered by a separate motor and has the advantage of being usable on any similar type vehicle. This design allows change to new chassis when desired.

The slip-on usually has its own motor and allows the vehicle to be used for other administrative purposes when not required for fire control.

Weight.—Most units operate with a booster tank, and with water weighing 8 pounds per gallon the weight factor becomes important from the standpoint of efficiency and safety. Many vehicles now in use carry excessive overloads, which should be avoided. Weight of the power unit and pump is usually a minor consideration. Condition of roads and grades over which the vehicle will operate is always a major factor in the selection of the unit best suited to local conditions.

Pressure.—The amount of pressure required depends on planned use of the unit. Pumps developing up to 300 pounds are desirable for pumping direct from water source up steep hillsides through 1½-inch hose. Lower pressures, such as that developed by a fan-belt pump, are required where it is used almost exclusively in connection with 200 to 300 feet of ¾-inch hose and employs the booster tank as a source of supply. Advantages of higher pressures are under investigation.

Nozzle pressure.—Units using a 1½-inch hose line should develop a nozzle pressure of 50 pounds through a ¼-inch nozzle under average working conditions. A delivery of approximately 5 gallons per minute through 300 feet of ¾-inch hose line and an ordinary garden-hose nozzle is usually adequate for the lighter pick-up units.

Abrasives in water.—Where water supplies contain abrasive materials, the use of the centrifugal pump should be considered. Most of the other types of pumps wear faster under such conditions.

Original and repair costs.—Original and repair costs on the various types of pumps should be investigated before making a final selection of the type which is best suited to meet local requirements.

PUMPS

Pumps as such offer a wide field for serious consideration in selecting the type best suited to the job. Study of the principle of operation, limitations, and advantages of each type, may contribute materially to the success or failure of the unit as an addition to the protective equipment.

Emergency situations or lack of sufficient units may, of course, preclude the possibility of selection of the right pump for all conditions. Familiarity with the major differences in pump units, however, will in most instances aid in the final selection. For that reason, brief descriptions of the characteristics of the rotary and centrifugal types are given below:

Rotary Pumps

General description.—Rotary pumps, often referred to as rotary-gear or rotary-cam pumps, like piston pumps, are of the positive displacement type. All rotary pumps of this general character consist of two intermeshing gears or cams revolving in opposite directions within a close-fitting housing. Variations occur mostly in the shape of the rotors and in transmission of power to the gears or cams.

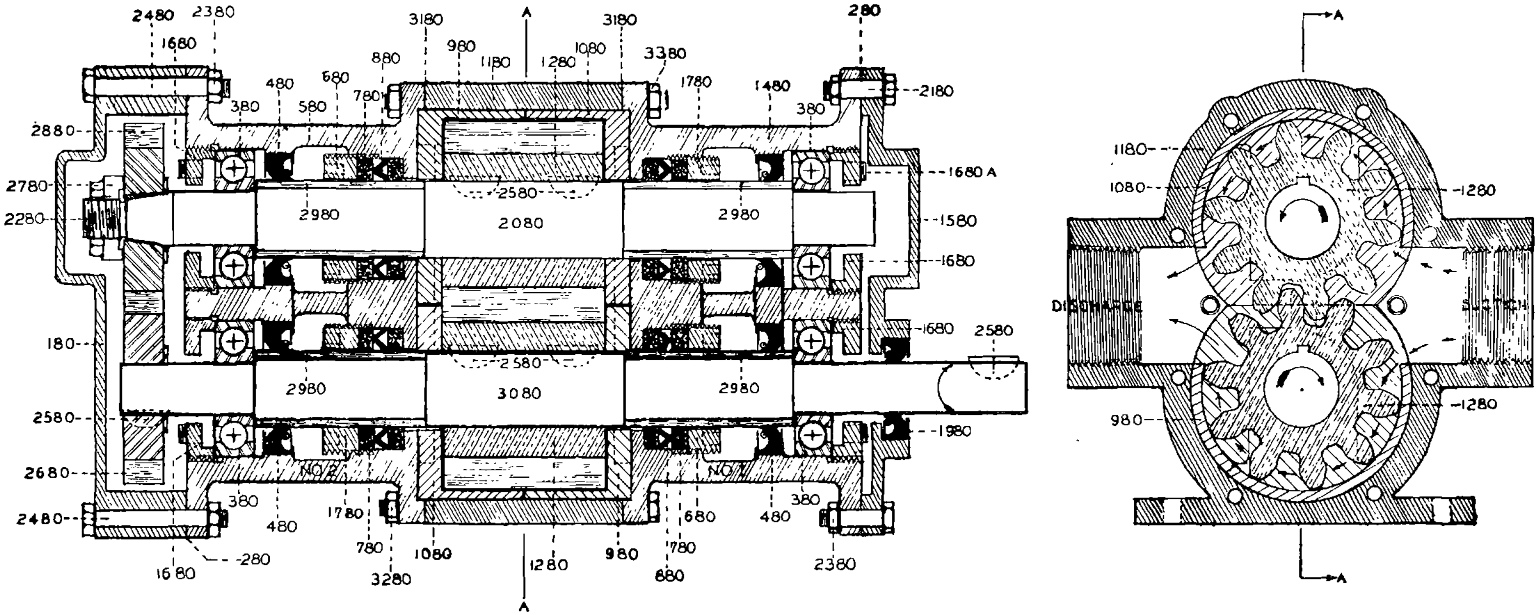
Discharge.—In general it can be considered that discharge with this type pump is proportional to the speed of the rotors. As wear develops and slippage occurs, discharge naturally falls off.

Pressure.—Since these units operate on the basis of positive displacement, pressures can be developed to the structural limits of the pump or power available by restricting discharge. For this reason, all pumps of this type must be provided with a relief or by-pass valve to avoid damage when discharge is cut off or restricted below the pump's capacity.

Advantages.—Rotary pumps are available in small sizes and, in general, for a given pump capacity, are smaller and more compact than other types. Rotary pumps, when in good condition, are capable of creating sufficient vacuum to be self-priming.

Disadvantages.—Because of the close clearance limits required for satisfactory operation, small quantities of abrasive material in the water will result in excessive wear and early failure.

In the lighter-weight units, where small pumps are used, high speeds are required to obtain adequate discharge. Slight mechanical variations from normal are so aggravated at high speeds that high precision in working parts is required for satisfactory operation. Therefore, small rotary or gear-type pumps as used on portable pumpers are usually more costly to maintain than centrifugal pumps.


2480
2380
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A
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1780
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280
2180
380
580
780
2880
2780
2280
180
2580
2680
1680 A
1580
2980
2080
3080
NO 2
NO 1
1080
1280
980
3280
1980
DISCHARGE
SUCTION
A

180	PILOT GEAR CASE COVER
280	GASKETS
380	BALL BEARINGS
480	GREASE SEALS
580	NO 2 PUMP END CASE
680	RIGHT HAND PACKING NUT
780	PUMP PACKING
880	PUMP CHEVRON PACKING
980	UPPER REAR-LOWER FRONT LINER
1080	UPPER FRONT-LOWER REAR LINER
1180	PUMP BODY
1280	UPPER AND LOWER ROTORS
1480	NO 1 PUMP END CASE
1580	NO 1 END CASE COVER
1680	PUMP ROTOR ADJUSTING NUTS
1780	LEFT HAND PACKING NUTS
1680A	LOCKING SCREWS
1980	FRONT COVER SEAL
2080	UPPER PUMP SHAFT
2180	BOLT & NUT
2280	COTTER KEY
2380	NUT
2480	BOLT
2580	KEYS $\frac{3}{16} \times \frac{3}{4}$
2680	PILOT GEAR-STRAIGHT BORE
2780	NUT
2880	PILOT GEAR-TAPER BORE
2980	BRONZE BUSHINGS
3080	PUMP DRIVE SHAFT
3180	PUMP BODY GASKETS
3280	NUT
3380	BOLT
←	INDICATES FLOW OF WATER
↷	INDICATES ROTATION

FIGURE K–1.—Rotary gear pump.

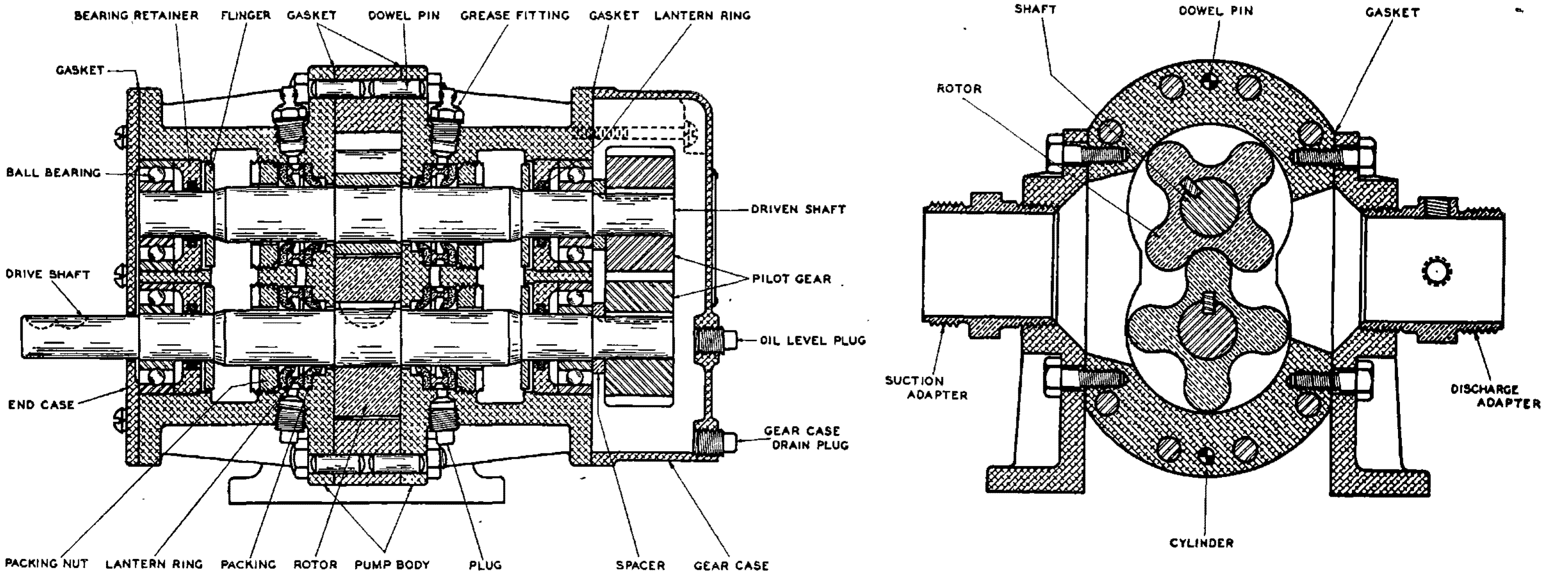

BEARING RETAINER
FLINGER
GASKET
DOWEL PIN
GREASE FITTING
GASKET
LANTERN RING
GASKET
BALL BEARING
DRIVEN SHAFT
PILOT GEAR
DRIVE SHAFT
OIL LEVEL PLUG
END CASE
GEAR CASE DRAIN PLUG
PACKING NUT
LANTERN RING
PACKING
ROTOR
PUMP BODY
PLUG
SPACER
GEAR CASE
SHAFT
DOWEL PIN
GASKET
ROTOR
SUCTION ADAPTER
DISCHARGE ADAPTER
CYLINDER

FIGURE K-2.—Rotary gear pump.

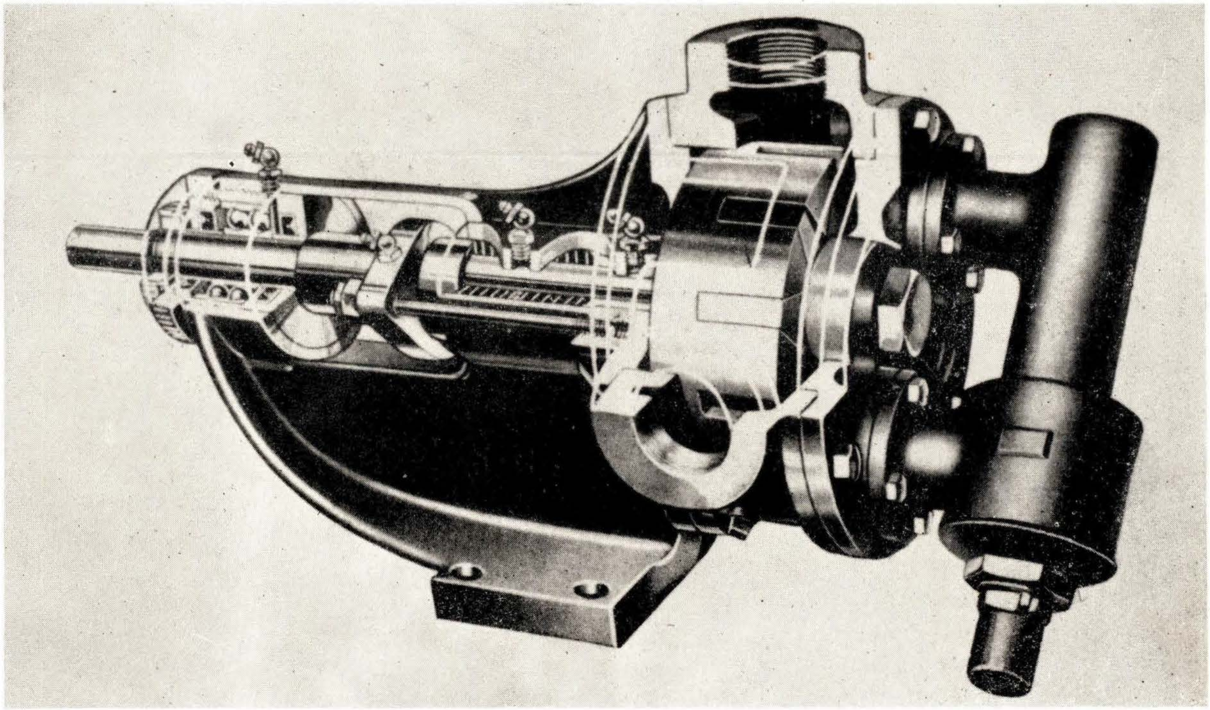


FIGURE K-3.— Rotary cam pump.

Centrifugal Pumps

General description.—Centrifugal pumps, unlike the piston and rotary types, utilize centrifugal force as the propelling medium.

An impeller housed in a suitable case, with provision for water inlet at its center, rotates to throw the water to the outer rim and in this manner develops pressure and discharge. If the discharge from the outlet of one impeller is connected to the intake of the other, the result is to discharge the same amount of water but double the pressure, and such pumps are called two-stage pumps. This procedure can be expanded to include several stages and results in the multi-stage pump, the number of stages depending on the number of impellers in the unit. Variations of this arrangement to include possible series or parallel connection of the individual stages result in the series-parallel centrifugal pump used in heavy municipal installations.

Discharge.—The discharge characteristics of centrifugal pumps involve several theoretical considerations. For all practical purposes, however, quantity discharge can be considered as proportional to the speed of the impeller when pumping at constant pressure. With speed constant and within certain limits, an increase in pressure will produce a decrease in quantity or vice versa.

Pressure.—With constant quantity discharge, doubling the speed will theoretically increase the pressure four times. Stated mathematically, pressure is proportional to the square of the speed when pumping with discharge constant. Unlike the positive displacement pumps, the quantity discharge, speed, and developed pressure are so interrelated that with any one of these three factors constant, a change in one of the remaining two will affect the other.

Advantages.—Centrifugal pumps do not require the close clearances between operating parts that are necessary with the positive displacement types. Because of this feature, centrifugal pumps will pass a moderate amount of abrasive material without damage to the unit.

A shut-off on the operating lines will cause a momentary increase in pressure and automatic slippage within the pump without causing pump or motor damage. Hence relief or by-pass valves are not necessary with small-size centrifugal pumps.

Centrifugal pumps, where they can be used, are generally less costly to maintain than the rotary type.

Disadvantages. — Centrifugal-type pumps are not self-priming and priming devices must be built within the unit or priming attachments added.

Entrance of a small amount of air when drafting will cause loss of prime, except in those units with built-in self-priming features.

For a given capacity, centrifugal pumps are generally heavier and larger than the rotary type.

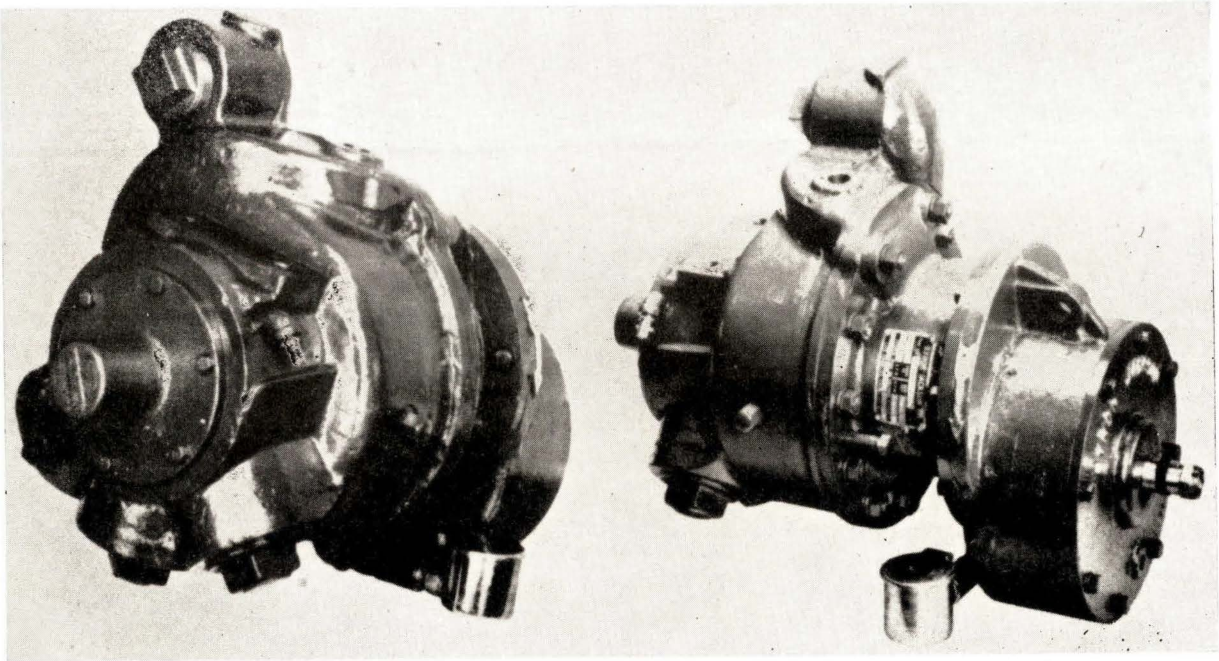


Figure K-4.— Two-stage centrifugal pump, designed for driving from a power take-off.

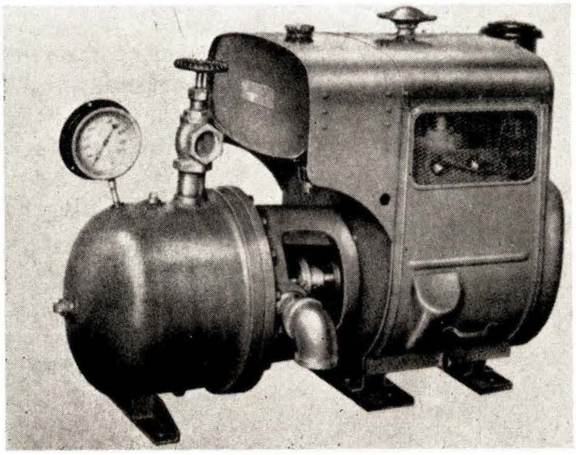


Figure K-5.— Four-stage centrifugal pump, directly connected to engine.

POWER DRIVES FOR PUMPS

There are several methods by which power may be supplied for pumps mounted on tank trucks or patrol units. Accepted types vary considerably and depend to a great extent on local conditions, salesmanship, precedent, and funds available. Features of the more common methods used are described below.

Power Take-Off Drive

Power transmission from the truck engine through the regular transmission, heavy-duty power take-off, and flexible shaft has been used extensively as a means for driving pumps ranging in size from the small rotary to the larger centrifugal type. This method is approved by several manufacturers as standard for power application.

Advantages.—Provides a lightweight and efficient means for utilizing the power of the truck engine. Simple to install and gives relatively trouble-free operation, provided the limits of the take-off are not exceeded and drive shaft assembly is adequate. Initial cost is low when compared with independent drives.

Disadvantages.—The direct connection to the vehicle transmission introduces problems of flexibility which under certain conditions may prove troublesome. When the truck is moving there is a direct relationship between the speed of the vehicle and pump which works adversely when discharge is necessary at high pump performance and low speeds, or when the opposite condition exists.

A common tendency when using power take-off drives in conjunction with heavy-duty pumps is to overlook the rated capacity of the take-off as related to the power requirements of the pump. Heavy-duty-type power take-offs are designed to transmit up to 30 horsepower, while lightweight units will not handle loads in excess of 12 horsepower.

If power take-off is used to drive heavy-duty pumps for extended periods, it is usually necessary to provide the truck with a heavy-duty radiator or install auxiliary engine cooling facilities.

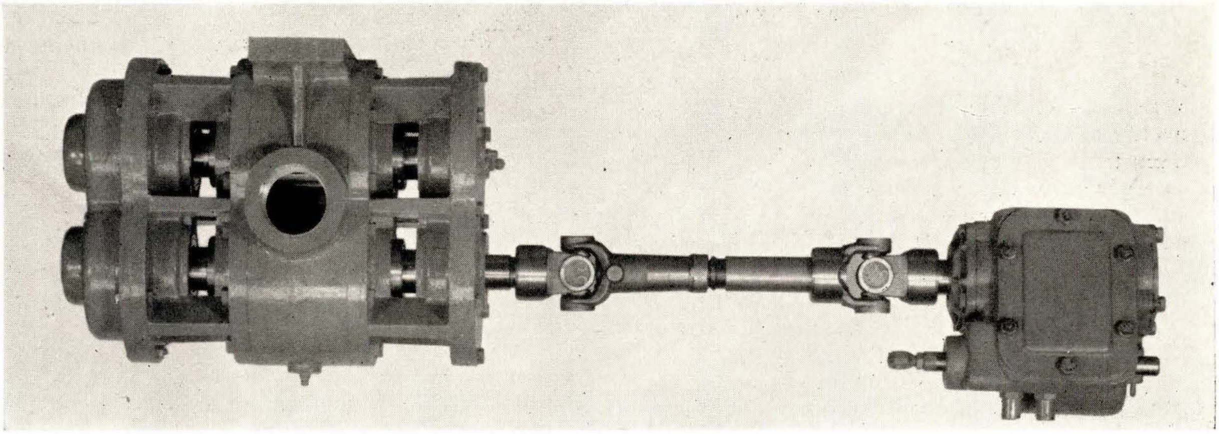


FIGURE K-6.—Power take-off assembly, with rotary gear pump.

Front-End Drive

In this type mounting, the pump is attached to the front end of the truck by means of a special frame. Power is transmitted to the pump through special clutches which are connected to the front end of the engine crankshaft.

Advantages.—Front-end mount allows for easy access to pump unit, resulting in simplified maintenance. Pumps in the higher discharge-capacity brackets can be readily mounted in this manner. To mount high discharge-capacity pumps for power take-off or midship-drive very often requires considerable chassis alteration and expense.

Disadvantages.—As with power take-off drives, there is a direct relationship between the speed of the pump and truck.

Because of the connection between pump and engine, damage to the pump caused by even a minor collision may result in serious damage to the engine. It is usually necessary with this type drive to provide auxiliary cooling facilities when used with standard truck units.

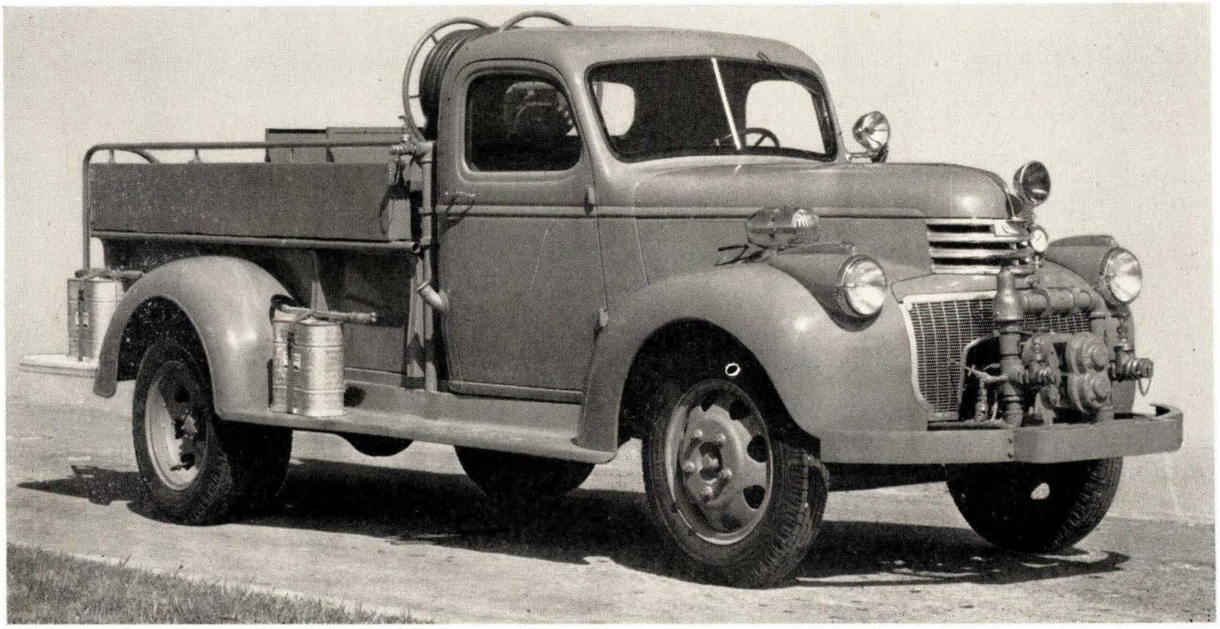


FIGURE K-7.— Front-end mounted rotary gear pump.

Independent Or Separate Engine Drives

With this type of installation, it is necessary to purchase a separate engine to drive the pump. Where practicable, the engine is directly connected to the pump, thereby reducing to a minimum the requirement for separate-drive mechanism. Usually, the combination is mounted on a sub-base, allowing for removal or installation as a unit (see figure K–5). Rotary gear and rotary cam pumps can, of course, be mounted in the same manner.

Advantages.—The independent engine drive allows for maximum utilization of the pump characteristics under all operating conditions and provides a flexibility in operation that is not equaled by any other type drive.

Slip-on or demountable construction is simplified when this type drive is used.

Pump and engine unit can be mounted so as to be readily removed from the tanker for repair or replacement.

Direct connection between pump and engine eliminates the need for maintaining clutches and drive mechanisms.

Auxiliary cooling devices for truck engines are generally not necessary.

Disadvantages.—The requirement for a separate engine drive involves a higher initial cost than with any other type. The installation required for medium or heavy tankers, including the engine, will weigh in excess of other drives. In some instances the need for separate starting of the pump engine is considered a disadvantage.

Fan-Belt Drive

Small pumps can be mounted so as to allow drive by V-belt from the truck engine crankshaft pulley. The pumps designed for this type mounting are equipped with the necessary clutch arrangement, and, except for mounting bracket and belt, require a minimum of material and expense to complete the installation.

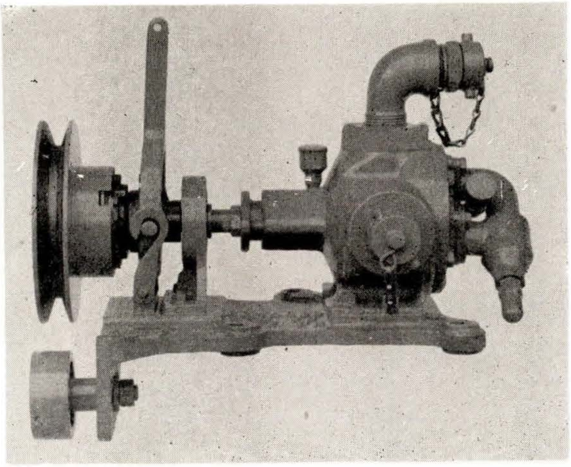


FIGURE K–8.— Fan-belt pump.

Advantages.—Provides an inexpensive pump unit where pump performance requirements are low.

The pump can be easily removed for storage or repair.

Because of its size it can be used effectively on pick-up installations where the question of weight is important.

Disadvantages.—Pump drive through the standard fan belt will cause overload and probably early failure. This, however, can be overcome through the use of a double V-belt installation with separate belts for fan and pump, or by providing extra belts for emergency use. Actual field experience does not show this disadvantage to be critical.

TANKS

The selection of the proper tank and tank capacity is an important factor in the successful operation of tanker equipment. Overload and structural failure has in many instances seriously affected operation of the unit. Of the two, overloading is probably responsible for a major part of the difficulty. Common practice has been to carry too much water, with the result that maneuverability, and in some instances safety, is sacrificed. Water, including the tank, weighs approximately 10 pounds per gallon. It is obvious from this that loads can accumulate very rapidly, and careful consideration should be given to limit of water load carried by any unit.

Capacity

One-half-ton pick-ups are probably the most abused from the standpoint of overload. This unit, with a rated load-carrying capacity of 1,000 pounds, can usually handle up to 60 gallons of water without overload. Any attempt to carry more than this should be carefully analyzed.

The ¾-ton pick-up offers what appears to be the more practical unit where a pick-up-type tanker is required. This unit, when properly designed, can handle up to 100 gallons of water safely.

Trucks in the 9,500-pound gross weight class, commonly referred to as 1½- or 2¼-ton, offer opportunity for a wide range of size and shape. Tanks in the capacity range of 270 to 300 gallons, however, will usually load the unit to its limit.

Shape

Where structural stability is a major requirement, elliptical or cylindrical tanks should be considered for installation. It can be shown that with this type torsional and localized strains, as well as baffle requirements, are minimized.

Rectangular tanks, however, offer a decided advantage when maximum utilization of space is required, and for this reason are the type most generally used. Much of the difficulty with rectangular tanks can be avoided if reasonable care is used in design and mounting. Where practicable, rubber or flexible mountings should be used.

Treatment

Tanks in certain areas are subjected to water conditions which require special consideration. Corrosion due to chemical or electrolytic action can cause leaks or structural failure in a very short time.

Where chemical action is suspected of causing damage, an analysis of the water will answer the question. If chemical action is the cause of the trouble, treatment of the tank interior with some protective coating will be necessary. There are several products available commercially for this purpose. Experience with tank treatment indicates that one coating with a good product will protect the tank for approximately 3 years under severe conditions. It is recommended, however, where trouble of this nature exists, that the problem be referred to the Division of Forest Research, U. S. Forest Service, Washington, D. C., or to a commercial organization familiar with tank treatment, before any definite action is taken.

In the event the water analysis does not reveal any unsatisfactory condition and corrosive action exists, electrolytic action should be suspected of causing the trouble. Correction is usually very simple, but requires a thorough understanding of the process involved. As with failure due to chemical action, it is recommended that advice be sought from the U. S. Forest Service or a competent commercial organization.

Construction

Several general considerations in connection with tank construction are presented below.

Tanks should have an outlet so that back-pack cans and canteens can be filled while the tanker is in operation.

Sumps should be designed so as to permit easy access for cleaning and draining. A common practice is to locate the sump outlet immediately below the filler cap so as to allow removal of any material which may clog the passage.

The tank should be provided with full capacity overflow, in order to protect it from accidental rupture when being filled under power.

Design should be such as to allow a full run-off in the event of overflow, to permit rapid drying.

Common practice has been to use metal for tank construction. Recent developments in the use of wood for this purpose should be investigated for possible application. Wood tanks would eliminate corrosion problems.

BASIC TYPES OF EQUIPMENT

To illustrate basic types, photographs of certain regional and other agency interpretations of local needs as to equipment are shown as listed below. Obviously, it would not be possible to include in this handbook a complete listing. In most instances minor variations of these designs will cover the field of forest-fire control.

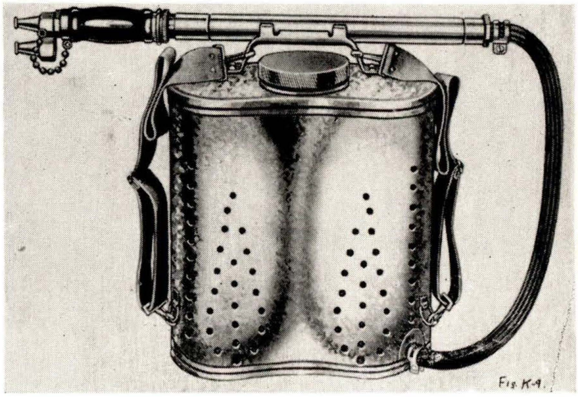


FIGURE K–9.— Back-pack pump outfit, with can and "trombone" pump.

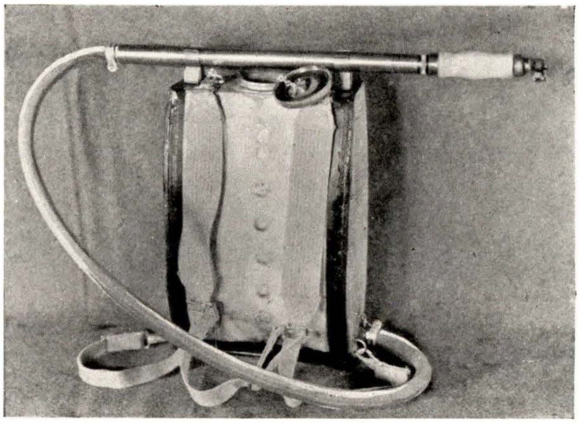


FIGURE K–10.— Back-pack pump outfit, with pear-shaped can.

Back-Pack Pump Outfits

Two types of back-pack outfits are shown in figuresK-9 and K-10. Component parts are described and illustrated on later pages.

Portable Power Pumpers

Four types of portable pumpers are illustrated below. Other pumpers are manufactured which may be just as suitable for the work to be done.

Two-Cycle Engine, Rotary Gear Pump.—

Length	24	inches
Width	12	inches
Height	13	inches
Horsepower	9.8	
Weight	68	pounds
Delivery	60	g.p.m. at 100 p.s.i.
Approximate cost	$600	

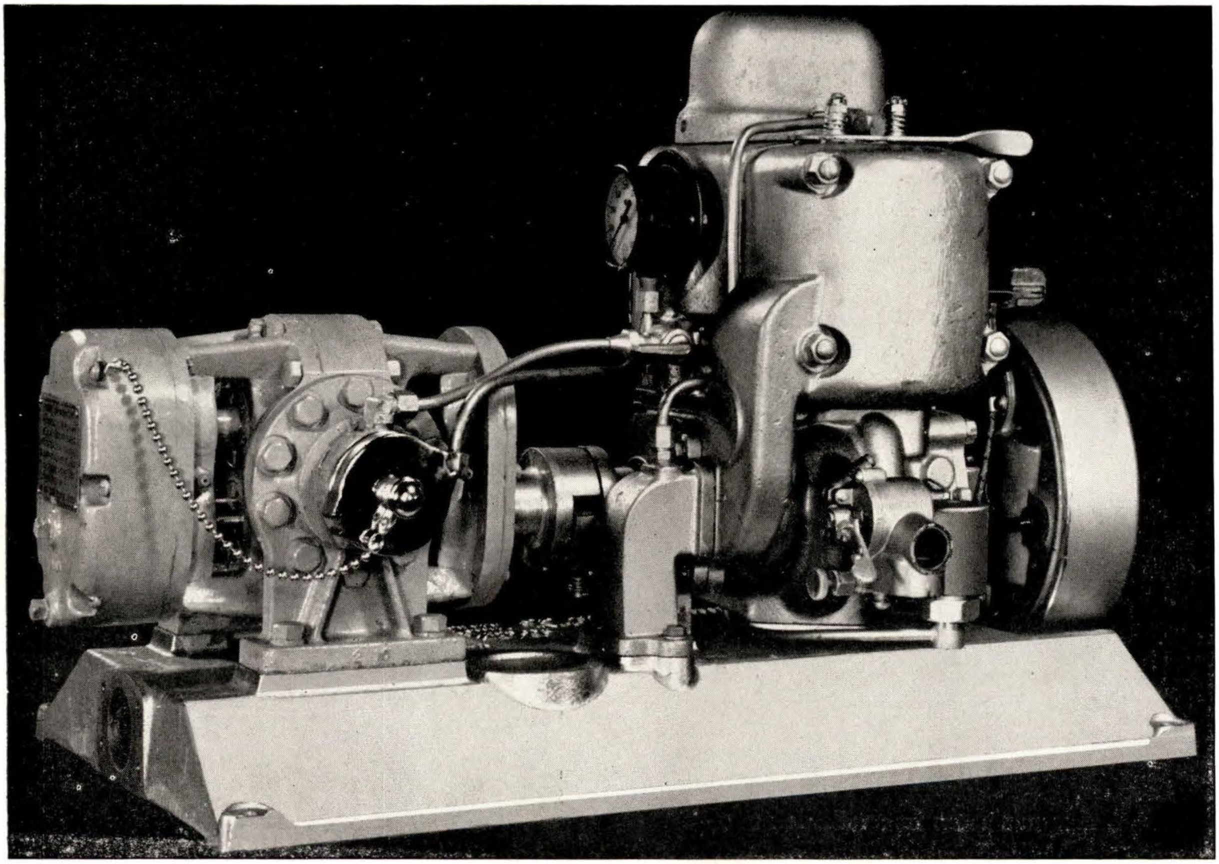


FIGURE K–11.— Two-cycle engine, rotary gear pump.

Four-Cycle One-Cylinder Engine, Rotary Gear Pump.—

Length	24	inches
Width	12½	inches
Height	19	inches
Horsepower	7.4	
Weight	115	pounds
Delivery	40	g.p.m. at 100 p.s.i.
Approximate cost	$385	

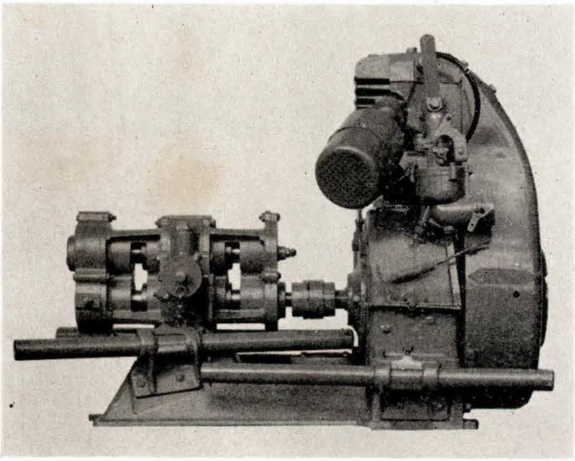


FIGURE K–12.— Four-cycle four-cylinder engine, rotary gear pump.

Four-Cycle Four-Cylinder Engine, Rotary Gear Pump.—

Length	34½	inches
Width	15	inches
Height	18	inches
Horsepower	16	
Weight	150	pounds
Delivery	80	g.p.m. at 100 p.s.i.
Approximate cost	$520	

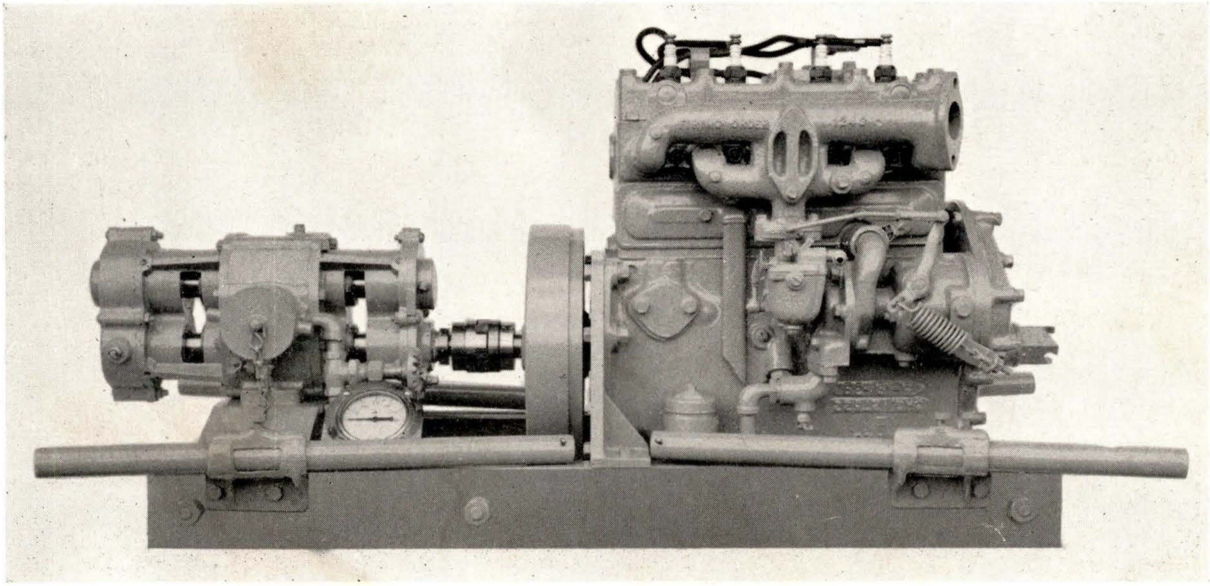


FIGURE K-13.—Four-cycle four-cylinder engine, rotary gear pump.

Four-Cycle One-Cylinder Engine, Centrifugal Pump.—

Length	22	inches
Width	20	inches
Height	23	inches
Horsepower	7.4	inches
Weight	220	pounds
Delivery	60	g.p.m. at 90 p.s.i.
Approximate cost	$260	

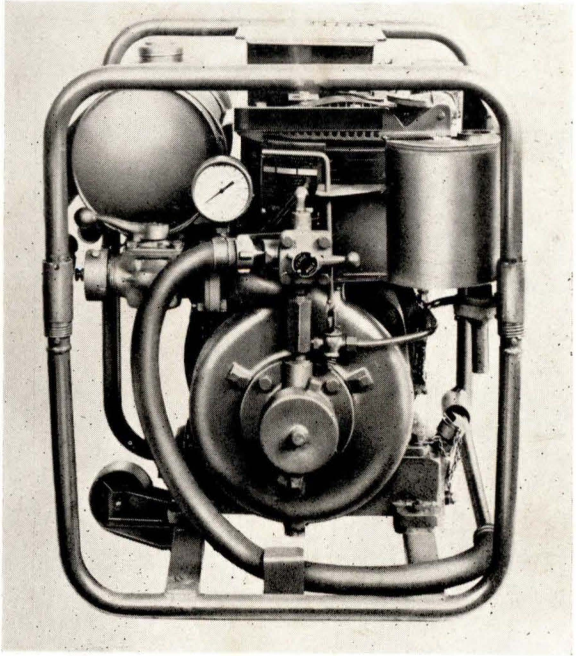


FIGURE K-14.—Four-cycle one-cylinder engine, centrifugal pump.

Pump, Tractor-Mounted.—(See Sec. S—Miscellaneous, p........)

Truck, Tank and Pump Units

Tanker, ½-Ton, Fan-belt Pump.—This is an outfit for use on a ½-ton pick-up truck in connection with a "V" belt-driven Panama pump mounted on the truck motor (fig. K–15). It consists of a 120-gallon tank of 12-gage material with a live hose reel, 450 to 500 feet of ¾-inch hose and an attachment for filling back-pack pumps from the tank. Water may be pumped from a stream or pond, or from the tank. The pump will draft water 15 feet and will deliver 15 gallons per minute at 100 pounds per square inch.

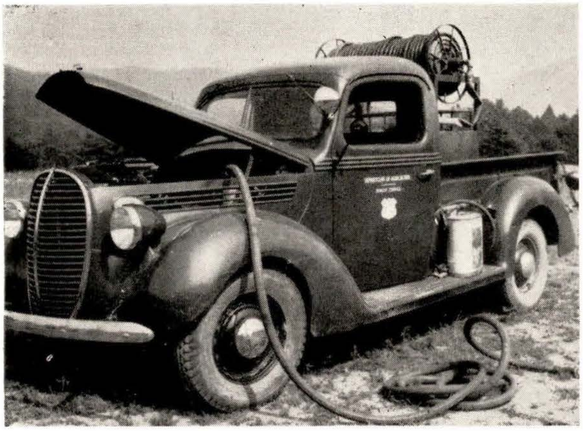


FIGURE K–15.—Half-ton tanker, with fan belt pump.

Size and Weight

Tank—24 x 28 x 44 inches outside measurement.
Weight, 242 lbs. empty; 1,244 lbs. full.
Capacity 120 gallons.
Reel—6-inch drum, 22-inch bands, 4 feet long.
Weight—67 pounds empty.
Hose—500 feet of common garden hose, weighing 250 pounds.
Suction hose, 25 feet, weighing 21 pounds.

Total weight of outfit filled with 120 gallons of water, 1,582 pounds; total weight empty, 580 pounds.

The cost of the outfit is approximately $300. Annual cost of maintenance and depreciation of assembly (except the pump itself), $25.

Tanker, ¾-Ton, R-6 Type.—The R-6 light tanker (fig. K-16) is mounted on a ¾-ton pick-up and designed for use by patrolmen in areas of special hazard, such as ponderosa pine cut-overs, where numerous logging and other roads are available, and areas of heavy man-caused risk.

The 115-gallon rectangular tank is placed just back of the truck cab to make room for two steel tool boxes, which hold tools for several men. A live reel for 300 feet of ¾-inch garden hose and a dead reel for 1½-inch CJRL or linen hose are mounted on top of the tank. Mobile VHF radio is installed.

The pump is mounted beneath the truck frame and driven from a power take-off. The earlier model has a gear pump of 40 g.p.m. capacity at a pressure of 100 p.s.i., with 2 to 1 power take-off and step-up gear to provide a ratio of 1 to 1.6 between engine speed and pump speed. The later model has a gear pump of double the capacity, with a power take-off of approximately 1 to 1 ratio and no step-up gear.

The estimated cost of the tanker, without chassis, radio, hose, accessories, or fire tools is $600.

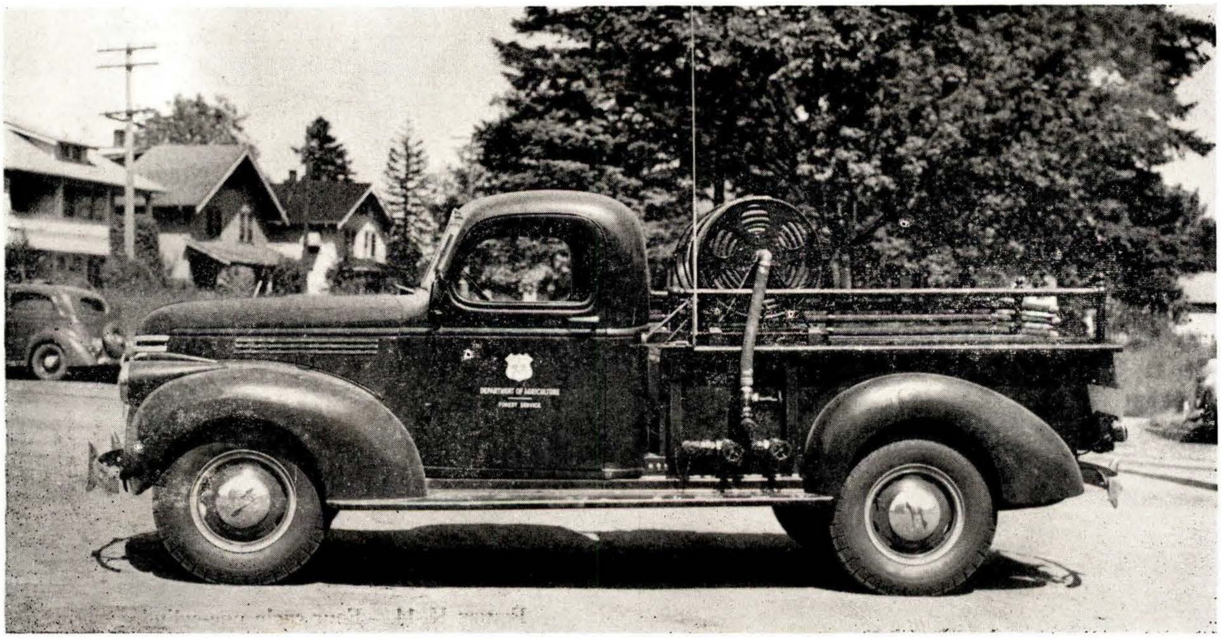


FIGURE K–16.—Three-quarter-ton tanker, R–6 type.

Tanker, ¾-Ton, Power Take-Off Drive, R-9 Type.—This unit (fig. K–17) is designed principally for use in checking or knocking down fast running fires. It is equipped with a power take-off driven gear type pump capable of delivering 18 g.p.m. at 700 r.p.m., a 100-gallon tank, live hose reel with approximately 300 feet of ¾-inch hose, vertical antenna for VHF radiophone, and a tool box.

Approximate cost of the pump, $60.

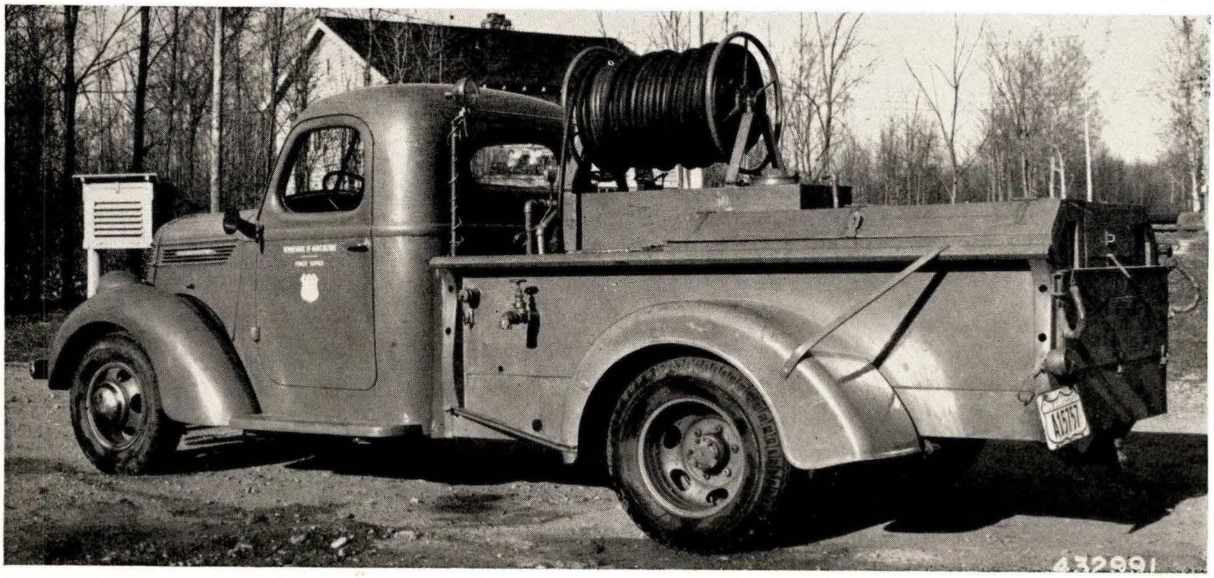


FIGURE K–17.— Three-quarter-ton tanker, R–9 type.

Tanker, 1½-ton, R–6-Type.—This unit (fig. K–18) is a demountable type, for mounting on a 1½-ton long-wheel-base chassis. The tank is rectangular, welded steel construction, 300 gallons capacity. The engine-pump unit is mounted immediately behind the tank, and there are two 2-man seats at the rear, with brush guards and wind protection. Compartments are provided along the sides for two live hose reels with 250 feet of high-pressure hose on each, truck and pump tools and accessories, a portable pumper, a portable radio, and fire tools. Suction hose and 1½-inch CJRL or linen hose is carried above the tank and compartments. Mobile VHF radio is also installed.

In some of these tankers, the power unit consists of a 25-horsepower V-type air-cooled engine and 4-stage centrifugal pump, with a capacity of 90 g.p.m. at a pressure of 100 p.s.i., or 20

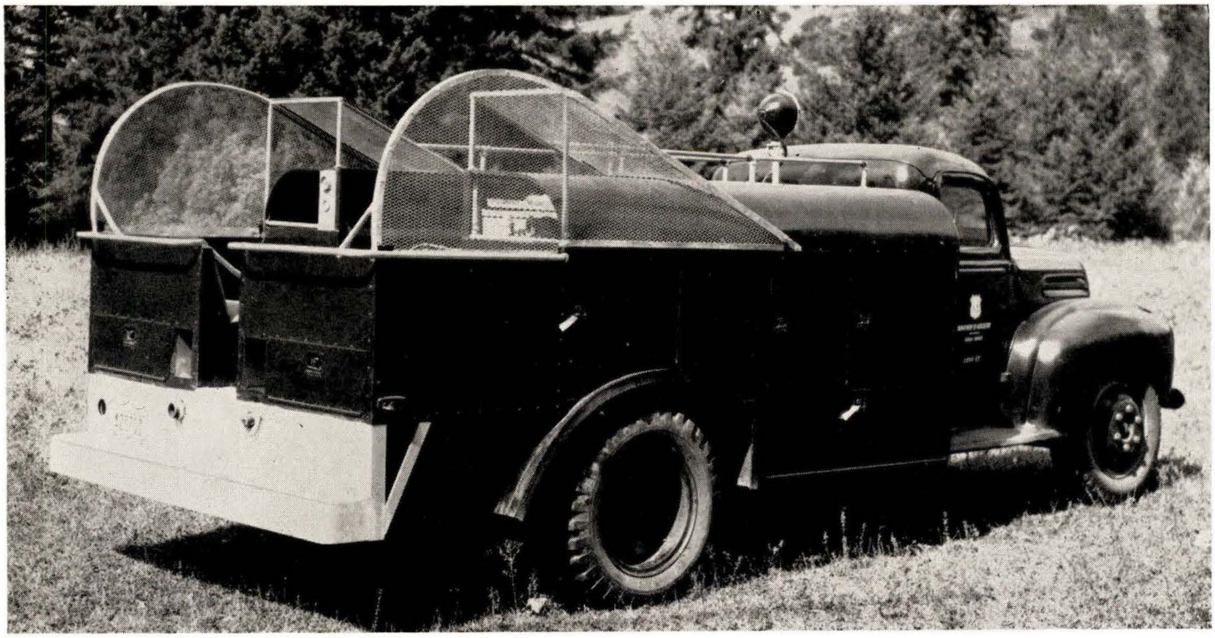


FIGURE K–18.— One and one-half-ton tanker, R–6 type.

g.p.m. at 400 p.s.i. In other units, a similar engine is used, with a rotary gear pump of approximately the same capacity as the centrifugal pump at a pressure of 100 p.s.i., but with a pressure limitation of about 250 p.s.i.

Cost will depend on the number of tankers constructed at one time. The average is estimated at $2,800 without chassis, hose, radio, accessories, or fire tools.

Tanker, 1½-ton, R-5-type.—This tanker (fig. K–19) consists of three separate assemblies; the tank and hose reels, the seat and fender housing, and the engine and pump. Each is constructed as a separate unit and is interchangeable with similar assemblies on other tankers. The entire unit can be dismantled and transferred to another chassis in approximately 6 hours.

The tank is elliptical in cross section, is of welded steel construction, has a capacity of 280 gallons, and is treated with a rust inhibitor. Each of the two live hose reels has a capacity of 250 feet of ¾-inch high pressure hose. The hose basket will hold 1,000 feet of CJRL hose.

Dry weight of tank assembly—900 lbs.

The seat will accommodate three men and is constructed to afford storage space below the cushion. Tool and accessory compartments are built in at the rear of each fender housing.

Dry weight of seat and fender housing—750 pounds.

The engine is a four-cylinder V-type, air-cooled unit rated at 25 horsepower at 2,400 r.p.m. The engine is complete with starter, generator, and gasoline tank with 6-gallon capacity.

The pump is a four-stage centrifugal type with provision for 2-inch discharge and 2½-inch suction inlet with a capacity of 90 g.p.m. at a pressure of 100 p.s.i. and 20 g.p.m. at 400 p.s.i.

Dry weight of engine, pump and piping, 1,000 lbs. Estimated cost of tanker, without chassis, radio, hose, accessories or tools, $2,700.

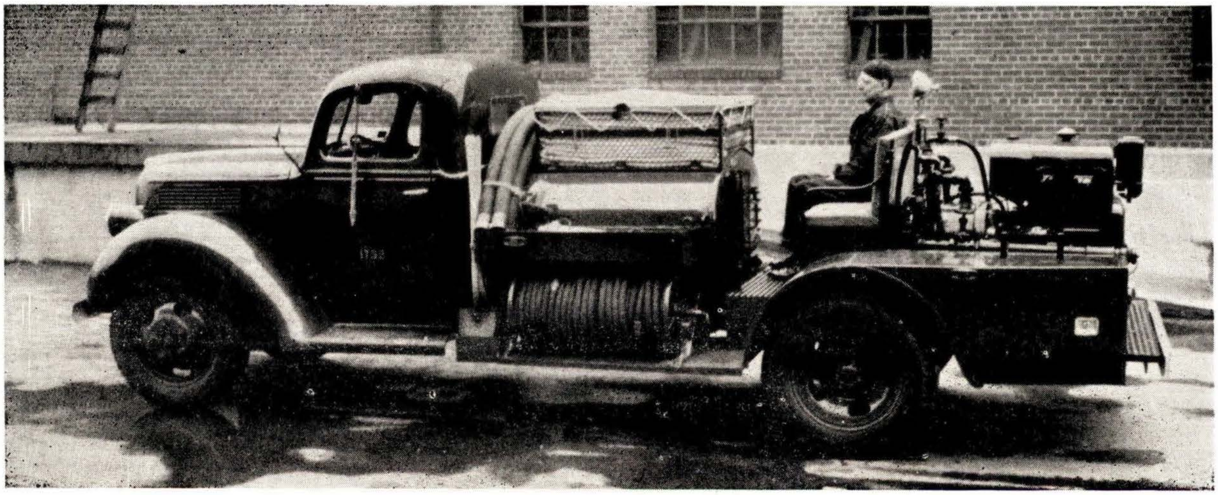


FIGURE K–19.— One and one-half-ton tanker, R–5 type.

Tanker, Slip-on, 1½-ton, R-5 Type.—This unit (fig. K–20) consists of a 4-inch channel frame on which has been mounted a tank and pumping unit. Four rollers to the side are provided to permit the unit to be rolled onto a stakeside bed. "U" bolts, not shown, are used to hold the outfit in place.

The tank is constructed of 16-gage galvanized iron and has a capacity of 190 gallons. The hose basket mounted on top of the tank serves as a backrest for the crew. Latex treated hair cushions provide a comfortable seat.

The power unit is a 5-horsepower, air-cooled 4-cycle engine directly connected to a 2-stage centrifugal pump. Performance range is from 15 g.p.m. at 140 p.s.i. to 70 g.p.m. at no head. A standard marine-type bilge pump is attached for priming.

Standard equipment as used in Region 5 includes 200 feet of ¾-inch high pressure hose, a shut-off nozzle with three tips, and four 8-foot lengths of 1½-inch suction hose with foot valve and strainer.

Dry weight, 475 lbs. Approximate cost, without hose and accessories, $650.

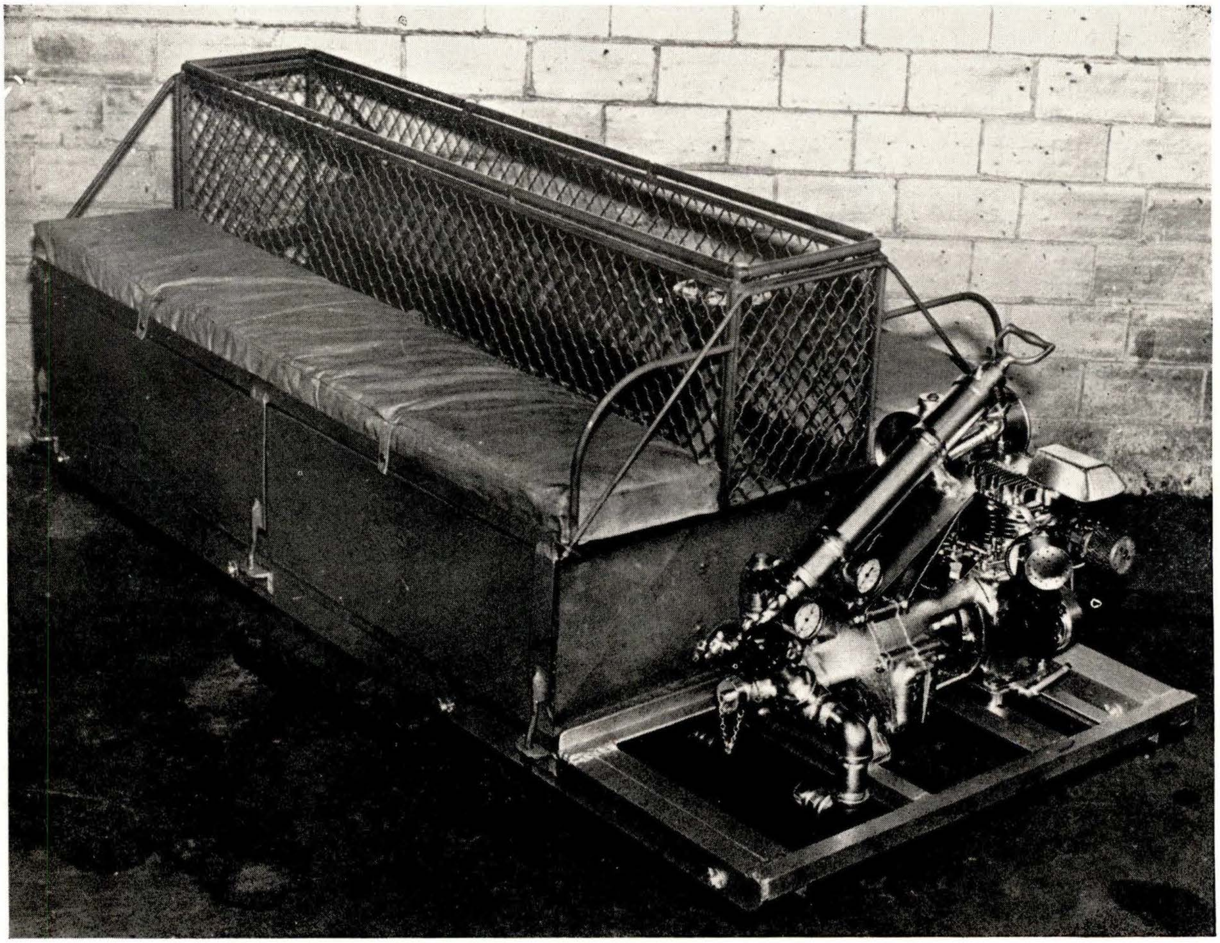


FIGURE K–20.— Slip-on tanker, R–5 type.

Tanker, Sled-Mounted.—This unit was developed at the Michigan Forest Fire Experiment Station. It consists of a 110-gallon cylindrical tank, a self-contained pumper, an auxilliary pump for quickly re-filling the tank, a reel with 100 feet of hose, and a tool box, all mounted on a sled-like base. A 2-horsepower engine drives both pumps.

The tanker may be hauled in a truck, but the Michigan Station has developed a special trailer, as shown in figure K–21, of channel steel and a standard automotive running gear, on which to mount the complete unit. The tanker costs approximately $350 and the trailer $100.

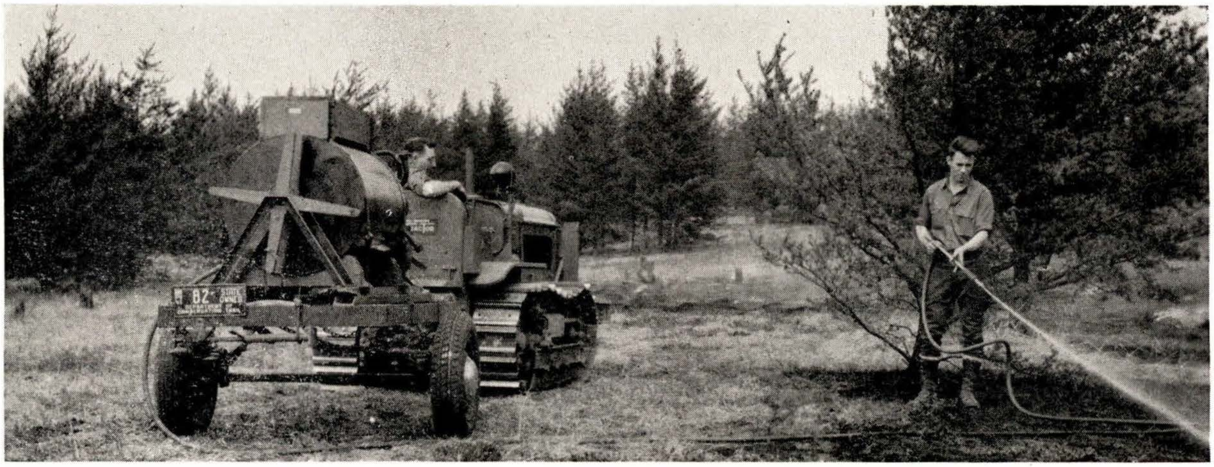


FIGURE K–21.— Sled-mounted tanker on special trailer.

Accessories

Can, Water, Back-Pack.—This type of 5-gallon can is shown in figure K–9. It is made of Armco zinc-grip steel, the sides being 26-gage, the top, bottom, and baffle plate 22-gage, the perforated shield 24-gage, and the carrying handle 18-gage. The top of the can is domed to prevent water lodging and running on the carrier's back. The bottom is recessed at least ¾-inch deep to prevent damage from stones and other things in rough country. Top and bottom are double locked-seamed to the sides and floated with solder. Net weight, 9½ pounds; approximate cost, $7.25 f.o.b. destination in cwt. shipments, including pump.

Can, Water, Back-Pack, Pear-Shaped.—Constructed of galvanized iron, 26-gage in the front and back and 24-gage in the sides and bottom. Capacity approximately 5 gallons. The bottom of the can is reinforced for extra durability, and the shoulder and chest straps are extra-heavy webbing. This can is shown in figure K–10.

The can outlet has an automatic check valve which prevents leakage when a filled can is transported with hose detached. A brass nipple, made for either ⅜-inch or ½-inch hose screws into the outlet. The filler cap is bronze, screw type, and has an automatic valve which seals the air vent except when the contents of the can are being discharged.

Brass spring clips for the standard back-pack pump are attached to the top of the can. If a handle is desired, it may be made of a leather or web strap with harness snaps at the ends for attachment to the dee rings at top of can.

Since this can is oil-tight it can be used with a flame thrower. It is also suitable as a fuel tank for a portable power pumper. The design is form-fitting and many users prefer it to other types of cans. Approximate cost, $9.

Pump, Hand, Back-Pack.—The Forest Service standard back-pack hand pump (fig. K–22) is commonly called the single-action, trombone-type. It is a positive displacement pump, with the piston acting alternately for suction and discharge. It has a capacity of about 8 cubic inches, is made of brass throughout, with wooden hand grip, and may be used with water or oils without excessive leakage. Three types of nozzles are provided. The pump is equipped at the rear end with a special combination hose nipple adaptable for ⅜- or ½-inch hose.

The single-action pump was selected as standard after a series of tests in which all makes and

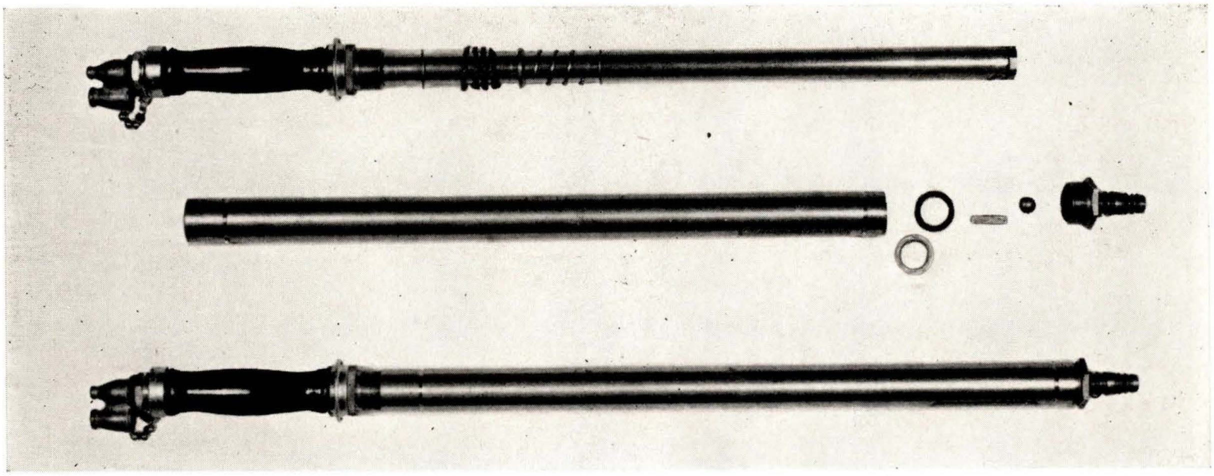


FIGURE K-22.—Back-pack hand pump and component parts.

models were compared for stream-projection, ease of operation, accuracy of stream direction, and general serviceability.

Net weight of pump, 2 pounds; approximate cost, $5.00 f.o.b. destination in lots of 100.

Hose, Back-Pack Pump, 3/8-Inch.—Constructed of oil- and water-resistant rubber composition, with five plies of closely woven high tensile strength fabric. Exterior diameter 11/16 inch. Weight 2½ ounces per linear foot. This type and size of hose is especially suited for use with back-pack pump outfits when extremely light weight and compactness are needed, particularly when the Osborne rubber bag is used.

Hose, Back-Pack Pump, 1/2-inch.—This hose is made of oil- and water-resistant rubber stock, with a woven braid of hawser-twist, high-tensile strength cotton insert. The outside diameter of the finished hose is approximately 7/8-inch. This size hose is ordinarily used with back-pack cans unless the more durable wire insert hose is desired. Weight, 3½ ounces per foot. Approximate cost, 17 cents per foot. (See fig. K-9.)

Nozzle, Hand-Pump, Twin.—Delivers either a solid stream or a spray, depending on which side is screwed to the pump (figs. K-23 and K-22). Made of brass. Weight 2½ ounces; cost, 75 cents.

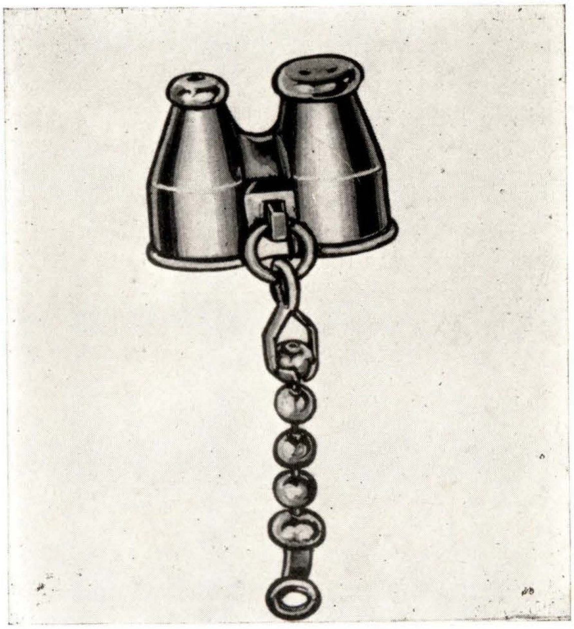


FIGURE K-23.—Twin nozzle for back-pack hand pump.

Nozzle, Hand-Pump, Adjustable Spray.—Mohawk brass nozzle. With only a slight turn of the nozzle, a stream, coarse spray, or fine spray may be had. Weight, 6 ounces; cost, $1.50 each. (Fig. K-24.)

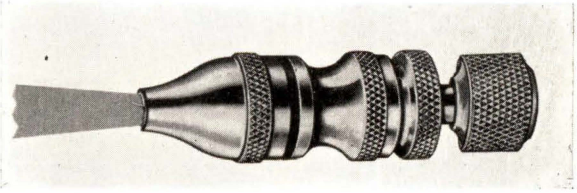


FIGURE K-24.—Adjustable spray nozzle.

Carrier, Back-Pack Water Can, Kidney-Shape.—Complete with bolts and nuts. A painted, strong steel rack, bolted securely to the floor or running board; the tank is strapped snugly into the rack. The straps are made of extra heavy 2-inch webbing. A flat, coiled steel spring on back strap takes up slack to tank when traveling over rough roads. The strap is adjustable and has a heavy enameled buckle which is instantly locked or opened. Weight, 2½ pounds; approximate cost, $4.20. (Fig. K-25.)

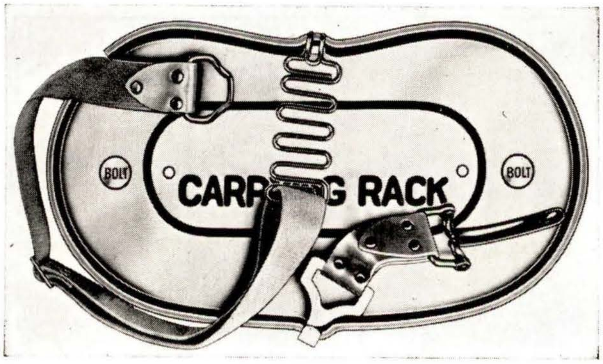


FIGURE K-25.—Back-pack water can carrier.

Carrier, Back-Pack, Water Can, Pear-Shape.—The back-pack water-can carrier, fig. K-26, is designed for carrying the back-pack can illustrated in figure K-9, together with hand pump, in a safe manner either on the running board of a car or attached to the side of a car or truck body. If intended for use on the running board, only item 1 of the specification need be used, but for use on the side of a car or truck item 2, a supporting frame upon which item 1 is secured, must also be used. Item 1, the main carrier, is a rubber-cushioned cradle constructed from angle iron and shaped to accommodate the standard back-pack water can. The can is strapped securely in place by a web strap supported at one end by a steel spring and fastened at the other end with a self-locking steel-finger lock.

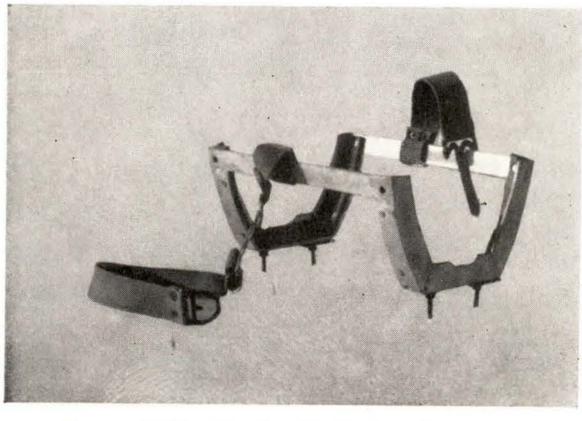


FIGURE K-26.—Carrier for back-pack water can.

Both items 1 and 2 of the carrier are included in the specification; therefore, when requesting these to be made up, the manufacturer should be notified as to whether one or both are desired.

Weight 6 pounds; approximate cost, $4.

Crate, Back-Pack Can and Pump.—This crate can be manufactured from any No. 1 grade 1- by 6-inch common lumber (fig. K-27). The ends should be bound with box strap. A crate approximately 27 by 18 inches by 19 inches deep, inside measurements, will accommodate four back-pack cans, but these dimensions may vary with the type of can used locally. Four pieces of 1½-inch fire hose are fastened to the under side of the lid and serve as sheaths for the pumps.

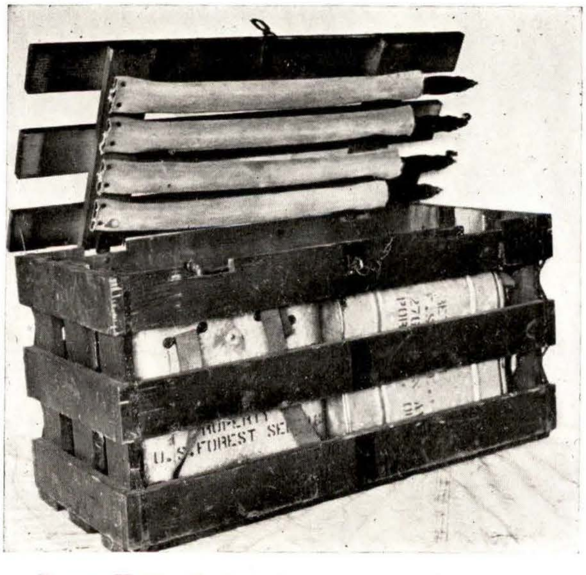


FIGURE K-27.—Back-pack water-can and pump crate.

Note: Figure number K-28 is missing.

Hose, CJRL, Special Lightweight, 1½-Inch.—Cotton-jacketed rubber-lined hose of the 1½-inch size comes in 50-foot lengths. The approximate weight per 50-foot length, coupled, is 15 pounds. The diameter of a 50-foot length of hose when rolled is approximately 20 inches. The Forest Service type aluminum-alloy coupling is required. The Forest Service specification provides for an entirely serviceable type of hose for rough usage and heavy duty. The minimum pressure-burst requirement of this hose is 600 pounds. Approximate cost, 27 cents per foot. (Fig. K–29.)

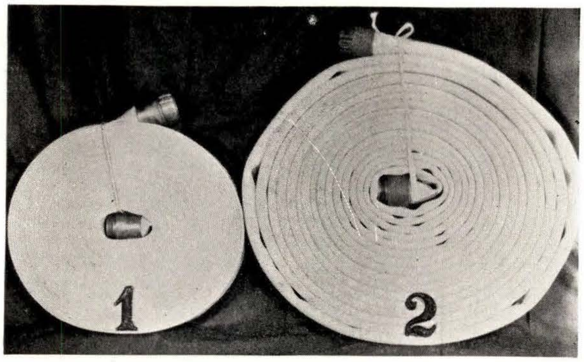


FIGURE K–29.— 1, 100 feet of linen hose; 2, 50 feet of cotton-jacketed rubber-lined hose. Both 1½-inch.

Hose, CJRL, Special Lightweight, 1-Inch.—The Forest Service specification provides a hose materially the same as 1½-inch cotton-jacketed rubber-lined hose except for the smaller diameter and, of course, less weight. Approximate cost, 22 cents per foot.

Hose, Linen, 1½-Inch.—The hose provided by the Forest Service specification is thoroughly mildew-proof and is constructed to withstand rough usage and heavy duty at high working pressures without excessive leakage (fig. K–29, 1). Linen hose leaks considerably until thoroughly wet and will withstand considerable heat and flame because of sweating. It is coupled in 100-foot lengths unless 50-foot lengths are specifically requested. The standard Forest Service type of aluminum coupling is used.

Linen hose weighs approximately 13 pounds per 100-foot length, coupled, and its bulk is about one-fourth that of cotton-jacketed rubber-lined hose of the same size. It is particularly useful where back-pack transportation is necessary. Approximate cost, 27 cents per foot.

Hose, High-Pressure, ¾-Inch.—This is heavy-duty noncollapsible water hose constructed to withstand a hydrostatic pressure of 1,000 pounds per square inch without leakage, undue distortion, or slippage of couplings. One-inch brass couplings with iron-pipe parallel thread are used. Weight, 25 pounds per 50-foot length, coupled. Approximate cost, 28 cents per foot.

Hose, Garden ¾-Inch. — In localities where high-pressure hose is not needed, good grade ¾-inch garden hose is used on tank trucks and for branch lines from take-off couplings or bleeder valves in 1½-inch hose lines. With tank trucks the hose is usually carried on live reels, coupled in lengths of 50 feet or more. To hold its shape on a reel, a good grade of hose is required. Approximate cost, 12 cents per foot.

Reel, Live Hose.—The reel illustrated in figure K–30 was designed in Region 5 for use on primary tanker equipment operating at pressures up to 500 pounds per square inch. It will hold 250 feet of ¾-inch high-pressure hose and is provided with spring-cushioned cross bars which allow for expansion and permit the use of any length of hose while pumping.

The packing gland is the high-pressure, ball-bearing swing-joint type, available commercially for about $12.

Dimensions: Width, 32 inches; wheel diameter, 18 inches; axle-pipe, 1¼ inches. Weight, with swing joint, 60 pounds. Cost of constructing the reel without the swing joint is approximately $32.50.

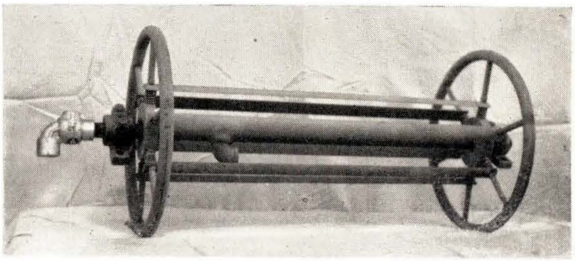


FIGURE K–30.— Live hose reel.

Tank, Canvas Relay.—A satisfactory relay tank for use with power pumpers can be made of a piece of heavy canvas 12 feet square, hemmed on all sides, with grommets at the corners and spaced along the sides about 3 feet apart. The edges of the canvas may be tied to trees or poles from 1 to 3 feet above the ground by pieces of rope made fast to the grommets so that the center of the canvas resting on the ground forms a tank. On a hillside, it may be necessary to dig a depression in which the tank may rest. If trees of suitable size are not available, stout stakes should be driven and poles fastened to them to form a support for the edges of the canvas.

Intake, Gravity Hose, Conical Type.—This type of gravity hose intake is made in the shape of a cone of 10- or 12-ounce canvas, with the large end sewed to a metal ring and the small end attached to a male hose connection with an ordinary hose clamp. Suitable dimensions are: Diameter at large end, 12 inches; diameter at small end, 1½ inches; length, 36 inches. The 12-inch ring may be made of ¼-inch iron rod. It is desirable to attach to this ring two pieces of ½-inch rope about 3 feet long for tying and holding the intake in proper position in the stream. A stiff coil spring, such as a bed or upholstery spring, may be inserted at the small end to sustain the intake.

Hose, Suction.—The Forest Service specification covers noncollapsible steel-wire-inserted hose, fitted with standard forestry-type couplings, for use with power pumpers. It provides for three sizes: 1½, 2, and 2½ inches in diameter, as required. To be furnished in 8-foot sections unless otherwise specified. Weight and approximate cost per 8-foot length are as follows:

Size	*Weight*	*Approximate Cost*
1-½ inches	8 pounds	$8.50
2 inches	15 pounds	10.50
2-½ inches	18 pounds	12.00

Suction hose, 1½ inches inside diameter, without wire insert, is on the market and is used in some localities, where it has proved satisfactory. It is lighter and less expensive than the wire-inserted type.

Strainer, Suction Hose.—The Forest Service specification covers a strainer which consists of a bell-shaped metal casting threaded at the small end to the size required and machined at the large end to accommodate a smooth screen-retainer ring. The screen is of 22-gage copper wire, six meshes per inch.

Study of the various types of strainers indicates that this particular type is less likely to pick up grit, flotsam, etc., than other types when properly used. The proper method is to face the opening downstream if in running water and to support it from the bottom of the stream with small poles or a board. When used in still water, the strainer should be supported from the bottom in the same manner, or inverted so that it faces upward several inches below the surface of the water. Where other methods are not practical, the strainer may be tied in a bucket.

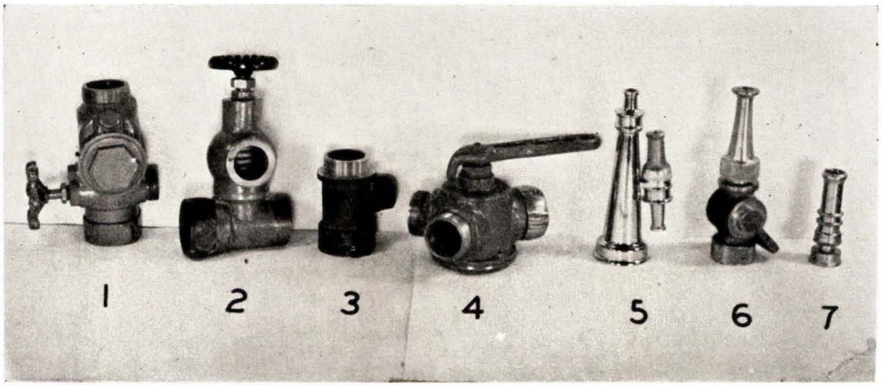


FIGURE K–31.—Power-pump accessories: 1, Swinging check and bleeder valve; 2, pressure-relief check valve; 3, 1½-inch tee coupling with 1-inch take-off, 4 siamese control valves; 5, screw-tip nozzle with extra tip carriers; 6, 1-inch shut-off nozzle with tip; 7, garden-hose nozzle.

The specification provides for three coupling sizes—1½, 2, and 2½ inches, as required. Weights and costs are as follows:

Size	*Weight*	*Approximate Cost*
1½ inches	3½ pounds	$ 4.50
2 inches	4 pounds	5.35
2½ inches	5 pounds	6.00

Couplings, Fire Hose, 1½-inch and 1-inch.—1½-inch hose are made of corrosion-resistant aluminum alloy, which insures a strong yet lightweight product. Such couplings are not as subject Forestry-type, slotted, swivel-ring couplings for to injury from dropping as bronze or brass couplings. They have iron-pipe parallel thread.

One-inch forestry-type, slotted, swivel-ring brass couplings are used on 1-inch cotton-jacketed rubber-lined hose and ¾-inch hard-rubber high-pressure hose.

Approximate weight of 1½-inch couplings, 11 ounces per set. Approximate cost of couplings per set 1 inch, $1.45; 1½-inch discharge hose, $1.60; 1½-inch suction hose, $2.20.

Coupling, Reducer, 1½- to 1-Inch I.P.T. or to ¾-Inch Garden Hose Thread.—An inexpensive type of machined brass reducer coupling for connecting 1½-inch fire hose to 1-inch fire hose or a 1-inch shut-off nozzle. A similar coupling has ¾-inch male garden hose thread. The edges are knurled to form a better grip. Approximate cost, $1.25.

Coupling, Tee, 1½-Inch with 1-Inch or ¾-Inch Outlet.—This unit (fig. K–31, 3) consists of a brass casting having male and female 1½-inch parallel iron-pipe threads and a hose nipple with either 1-inch parallel iron-pipe thread or ¾-inch garden hose thread. It is useful for insertion at some intermediate point in a 1½-inch hose line to take off a 1-inch or ¾-inch hose line. Approximate cost, $4.

Gaskets, Hose.—Gaskets for 1½-inch iron-pipe threaded fire-hose couplings to consist of a tread-stock ring 2 inches outside diameter by 1-7/16 inches inside diameter by ⅛ inch thick.

Gaskets for 1- and ¾-inch iron-pipe threaded fire-hose couplings. Specify tread stock and indicate the particular size required. No uniformity exists in these sizes.

Gaskets for ¾-inch nozzle tips to consist of standard tread stock for ¾-inch garden-hose coupling.

Nozzle, Shut-Off, 1-Inch.—A shut-off nozzle of the floating-valve type having a 1-inch female parallel iron pipe thread at the inlet and a ¾-inch garden-hose thread for the tips (fig. K–31, 6). The bore is ¾-inch and tips are available in sizes from ⅛- to ⅝-inch by 1/16-inch graduations. The nozzle is made of brass, with a smooth cast finish. The 1-inch size costs considerably less than 1½-inch and, with a set of tips and suitable adapter couplings, it fills all ordinary needs for a straight stream shut-off nozzle to use with hose from ¾-inch to 1½-inch, inside diameter. A standard garden hose or other type of spray tip with garden hose thread can also be used. Approximate cost, $10.80.

Nozzle, Screw-Tip, with Extra Tip Carrier.—Suitable for portable power pumpers or other uses where a shut-off nozzle is not required (fig. K–31, 5). Constructed of corrosion-resistant metal and having a holder to which can be attached two extra tips. Tip thread and size ranges are identical to those indicated for 1-inch shut-off nozzle. Constructed in the 1½-inch size only. Approximate cost, $3.60.

Nozzle, Garden Hose.—This nozzle (fig. K–31, 7) is a heavy-duty, cast-brass, garden type for use with shut-off and screw-tip nozzles, or for attachment directly to ¾-inch garden hose. Adjustable from full stream through spray to shut-off, it has proved practical where intermittent use of a variable stream is desirable.

It is not designed to give scientific atomization of water and may not produce geometrically perfect patterns at all spray positions. It will, however, disperse the water in a spray so as to get increased coverage with small volume at pressures from 80 to 100 pounds per square inch. Its low cost and simplicity make it a very desirable accessory for any pumper. Weight, 8 ounces; approximate cost, 75 cents.

Valve, Siamese Control.—The siamese control valve (fig. K–31, 4) is designed to permit shutting off or opening the two discharge outlets alternately, or opening both at the same time. The 1½-inch discharge and intake outlets have parallel iron-pipe thread to fit Forest Service standard hose connections. Selective positions are marked on the top of the valve.

Earlier valves of this type permitted closing both discharge outlets at the same time, but this proved unsatisfactory, because in switching from one line to the other the valve core was moved past the shut-off position and, even though the switch was made quickly, strong back pressure was created for an instant. An operator's carelessness or accidental sticking of the valve could cause hose failure or damage to the pump. One manufacturer still provides for complete shut-off, but his valve is so designed that the operator must lift a spring-loaded pin to move the lever to the full shut-off position.

It is possible to modify the earlier type of valve, at a cost of about $1.50, to prevent closing both discharge outlets at the same time. This is done by cutting an additional opening in the valve core, installing a lever stop at tht proper point, and remarking the lever positions. Details of the method may be obtained from Region 6.

Aluminum siamese valves on the market weigh 3¾ pounds, bronze from 6¼ to 8¼ pounds. Approximate cost, $14.75.

Valve, Pressure-Relief.—This device is suitable for installation next to the pump to provide a means of regulating the pressure in the hose line. It consists of a brass body with 1½-inch male and female fittings for hose and a spring pop valve, the tension of which is adjusted by a hand wheel (fig. K–31, 2). The relief valve may be set for any pressure from 50 to 300 pounds and will operate within close limits for the pressure to which it is set. The inlet or female connection is of the swivel type. Approximate cost, $12.

Valve, Swinging Check and Bleeder.—This unit consists of a brass body having 1½-inch female and male parallel iron-pipe thread for hose attachment (fig. K–31, 1). A swinging check valve is installed so that the pressure of a loaded hose line will be held by the check valve until the pump is again started. When starting, to relieve the pump load, a hand wheel is turned and a bleeder valve permits the pump to discharge at the valve. Once pump speed is reached, the bleeder valve is closed and as the pressure is built up the swing check opens and permits the water to again enter the hose line. Inlet or female connection is forestry swivel type. Approximate cost, $15.

Funnel, Filter Type.—Funnels used to fill gasoline lanterns or lamps, or the fuel tanks of light engines on portable pumpers, chain saws, grinders, and other power equipment, should be filter type to avoid plugged feed lines or faulty feeding or carburetion. If fine-mesh filters are not commercially available, a very efficient filter funnel can be made by soldering in the large end of the funnel spout a screen of 200- to 250-mesh monel screen cloth. This material may be obtained from copper and brass manufacturers. A 250-mesh screen will filter gasoline but will hold water from passing through. Approximate cost, 30 cents.

Bag, Pack, for Linen Hose.—A pack bag attached to a pack board is a convenient means of transporting and laying linen hose. In loading the bag, the hose should be folded back and forth, with the male coupling at the bottom. After the female coupling has been attached, the bag is carried forward and the hose pays out without attention. A leather-reinforced opening may be made in the upper side of the pack bag, as shown in figure 32, to facilitate paying out the hose. The ordinary bag used with a pack board will hold approximately 400 feet of hose when properly laid.

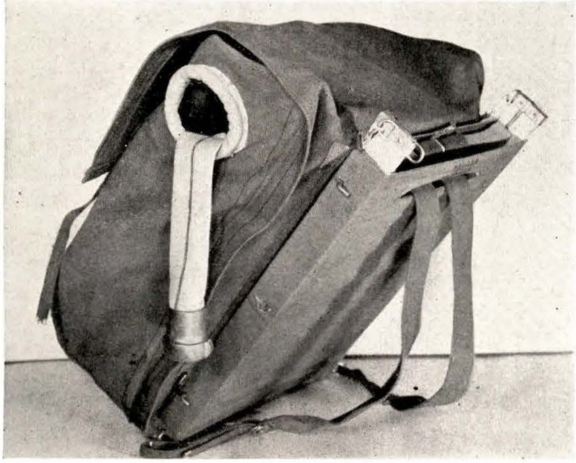


FIGURE K–32.— Linen hose pack bag.

Box, Power-Pumper Outfit.—The box shown in figure K–33 has a removable bottom. The pumper is fastened to the bottom, and the box is set over it and secured with four hasps. A solid horizontal partition is installed above the center of the box, so that accessories can be carried without damage to the pumper. A 5-gallon can of gasoline and extra oil may be carried in the bottom compartment. Cleats and additional partitions may be installed as necessary to separate accessories.

Construction is of 1-inch lumber, the edges being reinforced with heavy metal box strap. Heavy chest handles are used. Inside dimensions of box illustrated: Length 30 inches; width 18 inches; height 26 inches. Weight approximately 70 pounds. Approximate cost, $10. Dimensions may vary with type of pump and accessories.

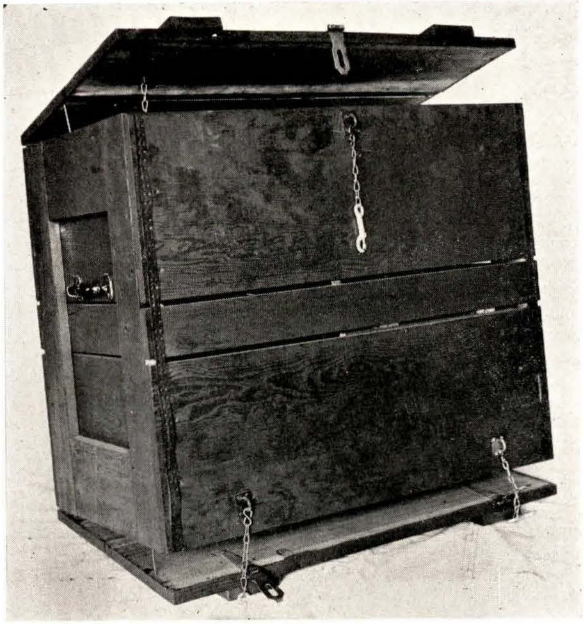


FIGURE K–33.— Power-pumper outfit box.

Box, Accessory, Metal.—Region 5 uses a small metal container for portable power pumper tools and accessories. It is made of 18-gage galvanized-iron sheet in the form of a chest approximately 18 inches long, 10 inches wide, and 10 inches deep.

It will accommodate the ordinary tools and accessories needed, except suction hose. Approximate cost $11.

SECTION L

FIRING EQUIPMENT

Torch, Liquid-Gas.—The liquid-gas torch (fig. L-1) is used for backfiring on fire control lines and for firing slash. Advantages of this type of torch are that the burner can be lighted with a match without preheating, and intense heat is produced. Disadvantages are its weight, use of special fuel that must be transported in heavy pressure cylinders, and difficulty of filling the fuel container in the field.

The torch consists of a cylindrical steel container, I.C.C. tested, approximately 7¼ inches in diameter and 25½ inches high, including control valve at top; a 4-foot length of acetylene hose, with control valve at center; and a burner made of heavy brass tubing, ⅝ inch in diameter and 2 feet long, to which is attached a copper-bronze burner head, approximately 2 inches in diameter and 6 inches long.

The fuel tank has a safety plug and the top valve assembly is well protected. Since it is very important that the tank have a reserve air space of 10 percent when filled, the valve assembly includes a small needle valve, which is opened before filling. When liquid gas begins to flow from this needle valve, it indicates that the tank is filled to the proper point.

For convenience, the torch is attached to a light pack board with two light steel straps. The total weight of the filled torch and pack board is about 42 pounds, including about 10 pounds of fuel. Approximate cost of the torch, $18.

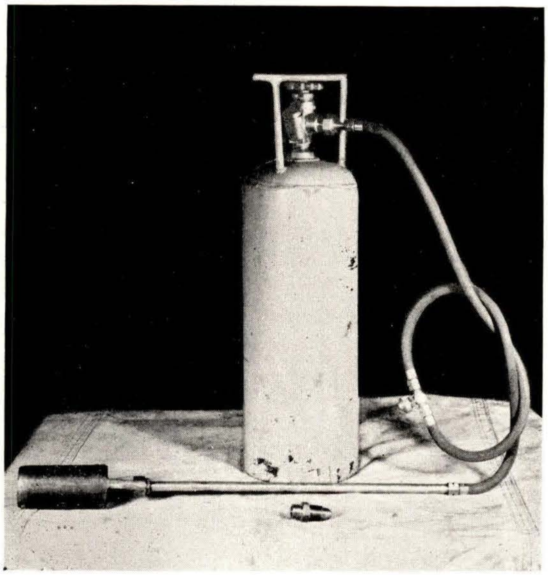


FIGURE L-1.— Liquid-gas torch.

Gas, Liquid.—Liquid petroleum gas suitable for use in torches must provide adequate vaporization at low temperatures, have a high heating value and a reasonably low vapor pressure, and be of such composition that its combustion and flame characteristics will not be altered as the cylinder becomes depleted. It must also be free from corrosive compounds, free of sulphur, or water, and should contain an odorant so that leaks in the container or connections will be quickly detected. There are various commercial gases available which possess all of the required characteristics for satisfactory operation of liquid-gas torches. Commercial propane gas is suitable. Approximate cost, 5½ cents per pound.

Flame thrower.—A device (fig. L-2) for attachment to a standard back-pack pump, designed to produce a large volume of flame and heat for backfiring under adverse conditions, burning out islands inside the fire control line, defoliating standing fuel, and igniting green slash and other fuels in logging operations and on rights-of-way.

The internal design is such that a high turbulence is produced on the pressure stroke of the pump, causing an aerated stream of oil to be ejected across the lighted wick. The aerated stream carries flame to the objective and ignites such oil as reaches the ground unburned. The check valve in the nozzle body cuts off the oil at approximately 5 pounds pressure.

In operation, the asbestos wick, approximately 1½ inches beyond the nozzle, is saturated and lighted. Thereafter the wick is held below the nozzle, so that a few drops of oil will reach it at each stroke of the pump. Careful attention must be given to safety. The fuel should be saw oil, diesel oil, or kerosene—never gasoline. The back-pack can must have a screw-type filler cap, with oil-proof gasket and check valve. Hose must be oil-resistant and all connections must be tight. Care must be used to prevent accidental spilling of oil on the operator's clothing, and if this occurs, he should not use the flame thrower or approach an open fire. Weight of flame thrower, 20 ounces. Approximate cost, $3.50.

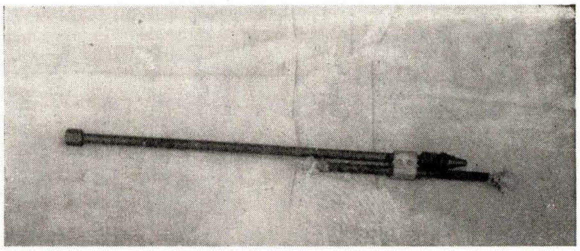


FIGURE L-2.— Flame thrower tip for back-pack pump.

Torch, Back-Firing, Fusee.—The fusee torch (fig. L-3) is effective for back-firing except under adverse conditions, where a hotter flame is needed. It is particularly useful where transportation is a problem.

Standard railroad fusees can be used, but the ferrule type covered by the Forest Service specification is more satisfactory. This specification provides for 10-minute and 20-minute fusees, the longer-burning one being 1½ inches in diameter and 20 inches long. One end of the fusee is primed for ignition when scratched lightly with the protecting cap, and a tin ferrule extends 3 inches beyond the other end for attachment of a stick. Two or more fusees may also be joined together by means of the ferrules.

These fusees will burn under any conditions; in fact, they will not go out when submerged in water. They are entirely safe to handle, transport, and store. Instructions for igniting and handling are printed on the side of each fusee. The 10-minute size is packed 24 to the box, and the 20-minute size 12 to the box. Approximate cost, 14 cents each for the 10-minute size and 20 cents each for the 20-minute size.

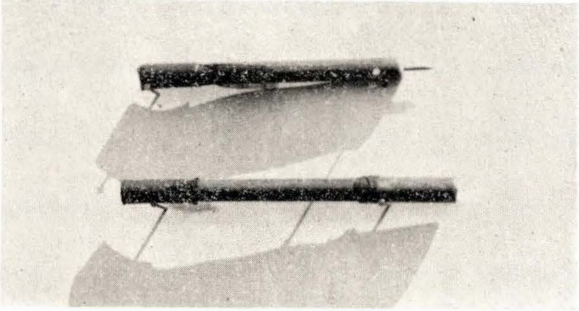


FIGURE L-3.—Ten-minute fusees, railroad-type at top; Forest Service ferrule-type at bottom.

SECTION M

LIGHTING EQUIPMENT

Light, Fire Finder.—Consists of the required length of standard drop-light cord, an enameled shade or reflector 6 inches in diameter, white inside and dark green outside, and a switch socket for a 4.5-volt Mazda globe. The light can be operated with a standard "hotshot" battery or three No. 6 cell telephone batteries. Many rangers use discarded telephone batteries.

The light is suspended directly over the lookout map board or fire finder where it can be switched on and off as needed for night detection work. The shade prevents the light from shining into the observer's eyes, directing it downward onto the map. Approximate cost, $1.70.

Headlight, Electric.—A specially designed headlight (fig. M-1) for work or travel at night. The head lamp is small, lightweight, and contains a bright-finished reflector. Experience has shown that a larger lamp may cause headache after several hours' use.

The battery container is light, compact, and rectangular in shape with rounded edges, and holds two 2-cell batteries and an extra bulb.. A two-way switch is provided so that the batteries may be used alternately to deliver a maximum of 3 volts to the 2.5-volt bulb. Tests have shown that with this arrangement, which permits one battery to recuperate while the other is connected, a usable light will be available continuously for about 8 hours. In addition to the advantages of using two batteries alternately rather than one 3-cell battery continuously, the rectangular container is much handier than a cylindrical container for carrying in the pocket or on the belt. Weight 1 pound; approximate cost $2.

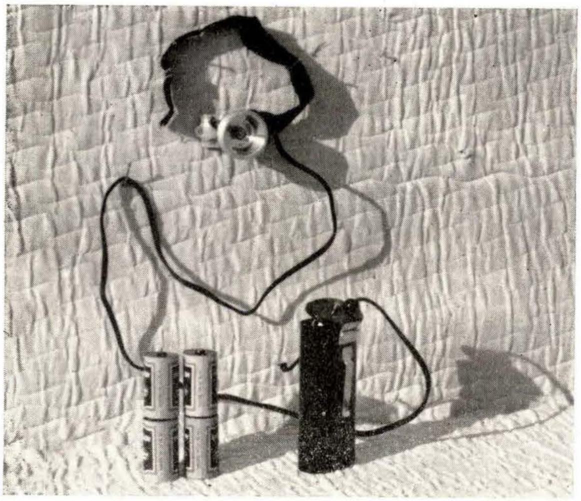


FIGURE M-1.—Electric headlight.

Head Lamp, Carbide with Cap.—The head lamp (fig. M-2) is used in connection with night work or travel on fires. Experience has shown that the carbide type head lamp is better under certain conditions of storage than the electric head lamp. Electric head lamps stored in caches at outdoor locations gather moisture, corrode, and batteries deteriorate. Carbide lamps withstand outdoor storage satisfactorily, as does the carbide chemical if kept in cans with tightly closed lids.

The lamp is constructed of brass, with a 2½-inch, polished, nickel-plated reflector. It is equipped with a round hook and clamps for easy attachment to a miner's cap. Burning capacity on one charge is 2 to 4 hours. The cost is about $9 per dozen lamps. Flints and other supplies and service parts are available on the market.

The miner's cap is of canvas or duck, flannel-lined, and equipped with fireproof lamp attachments. Caps are packed in lots of one dozen each, with sizes distributed as follows:

Size	6¾	6⅞	7	7⅛	7¼	7⅜
No.	1	2	3	3	2	1

The cost for caps is approximately $6 per dozen.

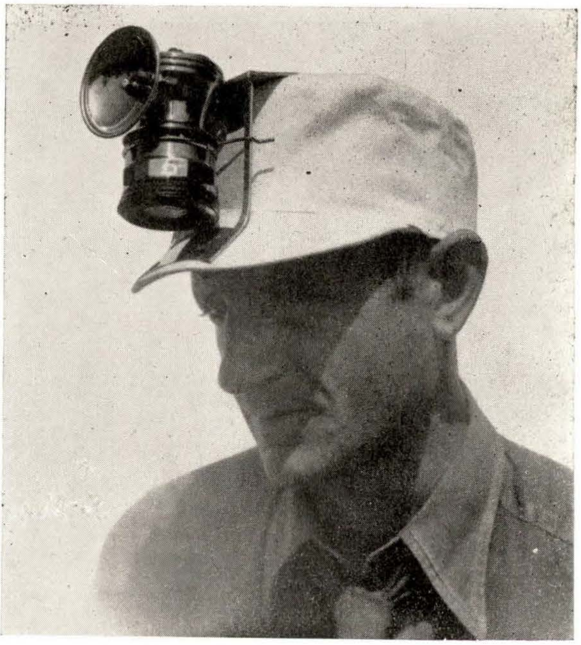


FIGURE M-2.—Carbide head lamp attached to miner's cap.

Lantern, Electric.—The electric lantern with adjustable focus, illustrated in figure M-3, is recommended for use with motor-vehicle equipment, power pumpers, and for special work on fire suppression or equipment service where a heavy duty dependable light is needed. The lantern uses a Mazda No. 35C type lamp and a twin-six battery which will furnish light for approximately 150 hours. The case is moisture-proof and provided with a handy thumb switch. The 3½-inch reflector is of silvered brass, and the lens is shatter-proof.

Dimensions: 4 inches wide, 3 inches deep, and 7 inches high. Weight of the lantern, 1 pound, cost, about $1.60; weight of battery, 3 pounds, cost, about 80 cents.

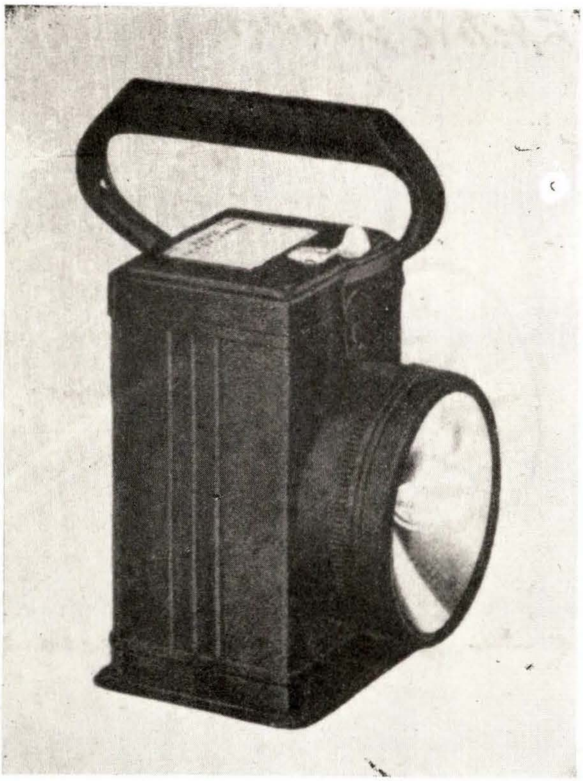


FIGURE M-3.—Electric lantern.

Flashlight.—A standard two-cell flashlight of rugged construction. The light is of the nonfocusing type with bright reflector and 2.5-volt bulb, using two standard 950 flashlight cells. The bottom cap is provided with a spring clip suitable for carrying an extra bulb, and a swinging ring for hanging up the flashlight. Approximate cost, 50 cents.

Flashlights as described may be purchased under Federal Specification No. W-F-421a, Type I, Style 1, seamless brass case, full chromium-plated or black enameled with chromium-plated fittings, or Type II, Style 1, rigid case with non-conducting exterior surface. If a 3-cell flashlight is desired, Style 2 should be specified. Spotlight and prefocused spotlight flashlights, either 2-cell or 3-cell, may be purchased under the same specification. Purchasers desiring these should review the specification in order to designate the particular article required.

Batteries, Flashlight.—Federal Specification No. W-B-101a, as amended, will provide any sort of flashlight battery desired. If the standard 950 flashlight cell is required, the purchase order or bid should also specify that the battery be according to type B-1d, cell designation D in table 1, of the foregoing Federal specification.

Flood Light, Carbide.—This acetylene gas generating unit (fig. M-4) is a source of brilliant light, and is advantageous where quick portable lighting is required, as around fire camps at tool supply points, kitchens, and truck parking areas. Gas is generated by the chemical reaction of calcium chloride and water. In the size unit most readily adaptable to fire control purposes, the burning period with one charge is about 12 hours. It furnishes a clear, penetrating white light at 8,000 candlepower under all weather conditions. It is readily portable, weighs 36 pounds when empty, and measures 45 inches over-all. Erected with the reflector in position, it is 79 inches in height. It is made up of three main parts, is easily assembled, and simple in operation. It uses carbic cakes of calcium chloride, compressed into briquette form.

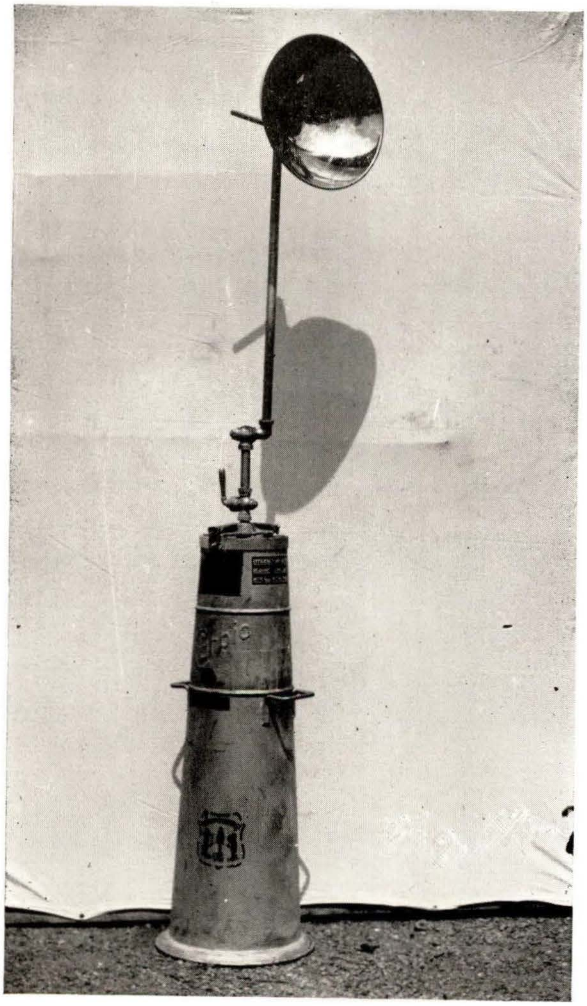


FIGURE M-4.—Carbide floodlight.

There are various floodlights comparable to the above description. Approximate cost of the one described above is $48.

Light, Plant, Fire-Camp, Electric.—The light plant illustrated in figure M-5 is a 700-watt, 60-cycle AC unit powered with a 1½ h.p., 4-stroke cycle, air-cooled, gasoline engine. For convenience the power plant has been permanently mounted on the base of the container, the cover of which is pinned and removable.

The accessory box is used to store the lead wire, light string, light globes, and a few tools. The lead line is a two-conductor rubber-covered cable, 125 feet long, provided with double twin receptacles at one end and a plug at the other. The light string is of No. 10 wire, 70 feet long, and provides seven receptacles for the 100-watt globes. Arrangement of the light string is a matter of choice and can be made to accommodate up to fourteen 50-watt globes.

This particular unit, while designed primarily for supplying power for radio communication, has proved very satisfactory for intermittent use as a fire-camp light plant. Because of its portability, it has won considerable favor in the field, particularly where camps are small.

Two units may be used where 700 watts is insufficient, thereby avoiding the necessity for a long transmission line, expensive high output generator, and a separate vehicle for transportation.

Several units similar to the one illustrated are available, some of which may be lighter in construction and therefore more suitable for portable use.

Unit	*Weight (pounds)*
Container for light plant (Width, 26"; depth, 17"; height, 20")	55
Light plant	102
Accessory box (Width, 42"; depth, 24"; height, 8")	43
Accessories	28

Fuel consumption is about ¾ gallon per hour at 1,800 r.p.m. Cost of the light plant without accessories and containers is approximately $200.

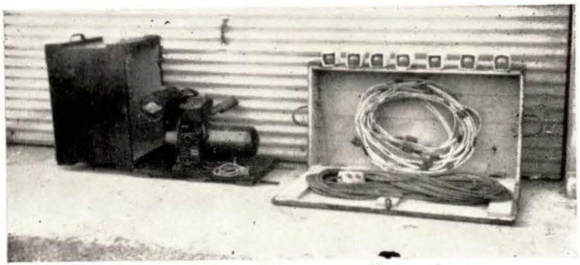


FIGURE M-5.—Fire-camp light plant.

Lantern, Gasoline.—The type of gasoline lantern provided for by the Forest Service specification is similar and equal in every respect to the commonly known Coleman two-mantle lantern. The specification provides for either the Q-type generator or the rotary, self-cleaner type, as may be preferred. It also provides that either mica or Pyrex chimney may be obained as preferred. Approximate cost, $6.50 each.

Carton, Gasoline Lantern. — A specially constructed, lightweight, corrugated fiberboard box suitable for transporting gasoline lanterns. Boxes of this kind can be obtained by using the following specification:

Specification.—Corrugated fibre box for gasoline lanterns. Box to be 7 x 7 x 15 inches, inside finished dimensions, in accordance with style No. 1 (collapsible slotted container), board No. 1, table No. 1 of Federal Specification No. LLL-B-631a including any amendments thereto. Approximate cost, 75 cents.

Funnels, Filter Type.—(Refer to Sec. K, Pumping Equipment.)

Candles, Hard Type.—To obtain a suitable type of candle for use in firemen's outfits and elsewhere, where a candle which will not soften and run is necessary, Federal Specification No. C-C-91 should be used, specifying type 2, class A, thereunder. Size 1$\frac{5}{16}$ x 4¼ inches. Approximate cost, 50 cents per dozen.

Carbide.—Carbide for use in headlamps and floodlights may be purchased under Federal Specification No. O-C-101, as amended. Nominal size ¼ x 1/12 inch, should be specified for headlamps, and egg or lump size for floodlights. The small size, for headlamps, is packed in 100-pound drums, 25-pound drums, 10-pound cans, and 2-pound cans. Approximate prices per container are, respectively, $5.25, $1.50, $1.00, and 25 cents.

While not covered by the Federal specification, carbide in compressed cakes, 4 inches in diameter and 3 inches thick, and weighing 2½ pounds, may be obtained for floodlights at approximately $5.60 per 100-pound drum (40 cakes).

Flare, Airport-Lighting.—This is a magnesium candle flare which provides a 75,000- to 80,000-candlepower light for a period of 3 minutes. It is for use at emergency landing fields to provide a light by which airplanes can be landed at night. The candles must be used with a hooded reflector so that the light will not blind the pilot.

To be most efficient, these lights should be used two at a time, placing them about 100 feet apart at the near end of the runway where the plane is to land, the reflectors focused down the runway like a pair of automobile lamps. One candle is ignited while the plane is maneuvering into position, the other when the pilot begins to glide toward the field. This provides the maximum light of both candles at the time the plane lands and insures a sufficient period of light to complete the landing. Approximate cost, $3.

Reflector, Airport-Lighting.—The reflector is an inexpensive piece of equipment so designed that any tinsmith can manufacture it, and any carpenter can manufacture the tripod which supports the reflector (fig. M-6). The specification covers in detail the construction of both the reflector and the tripod stand. The reflector is manufactured with a bright tin backing, over the top of which is placed a 24-gage galvanized-iron hood. It is approximately 48 inches high by 30 inches wide, and is fastened to a hardwood triangular-shaped stem which fits into a socket in the tripod stand. Approximate cost, $7.50.

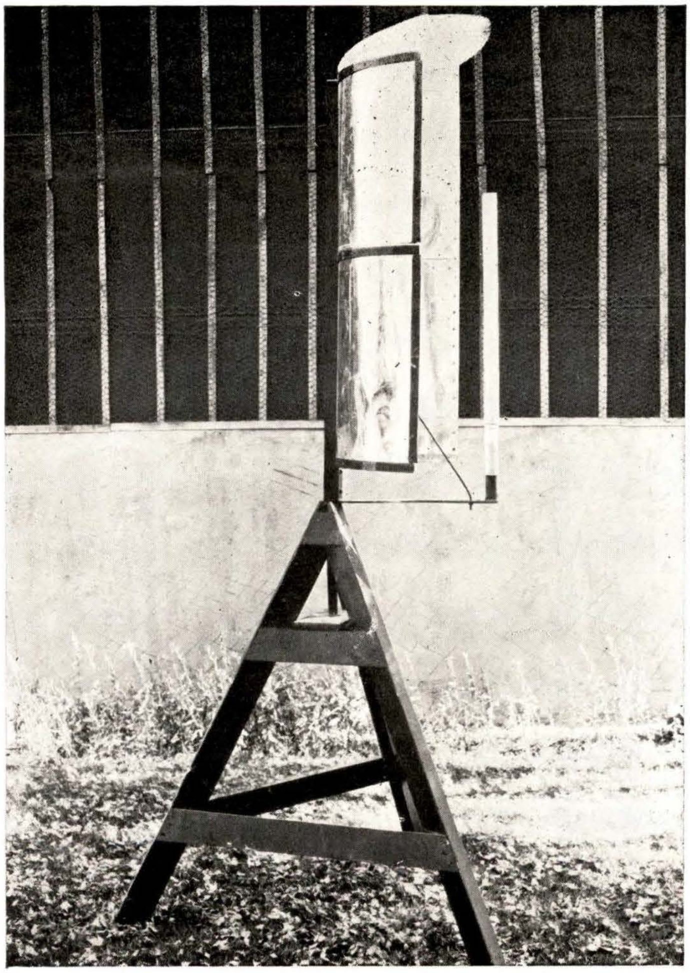


FIGURE M-6.—Airport lighting flare reflector.

SECTION N

CAMP EQUIPMENT

Camp-boss Outfit Containers. — The standard ranger's canvas carrying case is useful as a container for a small camp-boss or fire-timekeeping outfit. However, it will hold only a small supply of the stationery and forms essential for timekeeping and for inventory and requisition of equipment and supplies. For large fire camps, larger containers are necessary. Different designs in metal and wood are used in different regions and parts of regions. Many of them are homemade, with compartments for the various forms and supplies needed for particular localities and conditions. Anyone desiring information on the larger containers should write to one or more of the western regional foresters.

Sleeping Bags and Blankets

Blanket, Bed, Wool. — Federal Specification DDD-B-421a, type 2, as amended, will provide a wool bed blanket suitable for forest-protective work. Approximate cost, $3.35. The blanket recommended is 66 by 84 inches, olive drab color, and weighs either 4 pounds or 5.2 pounds, as specified.

Bag, Sleeping, Kapok.—For use by fire fighters and others in place of blankets, particularly in localities where transportation is a problem (fig. N-1). Provides a reasonably comfortable and fairly waterproof bed. Consists of an outer covering with carrying straps and head flap, a kapok mattress, and a slip-on mattress cover. Size 72 by 78 inches. The drawings in the specification can be altered to suit individual dimension requirements without affecting its provisions. Outer covering made of waterproof duck; mattress covering and slip-on cover of very light duck. All coverings fast-colored olive drab. Material is sufficiently strong to withstand years of hard use. Inner sheets and mattress easily removed for cleaning. Kapok mattress should never be laundered, but renovated by a suitable dry-cleaning method. Rest of bag can be laundered. Weight, 16 pounds; cost, approximately $16.

Bag, Sleeping, Goosedown.—The feather-weight sleeping bag, illustrated in figure N-2, is for use where transportation is a problem. It is particularly suitable for smoke chasers, suppression crews, and others traveling by trail or cross-country or working on remote sectors of the fire control line, and for aerial transportation, because of its compactness and light weight.

The complete bag consists of an outer cover 84 inches long, 36 inches wide at the head and 26 inches at the foot, made of airplane cloth, waterproofed, with a 36-inch or full-length zipper; a mattress with 1½ pounds of goosedown in a featherproof casing; and a bag-type sheet of broadcloth. Size rolled, approximately 9 inches in diameter and 18 inches long. Total weight 5¾ to 6 pounds; approximate cost, $13.50.

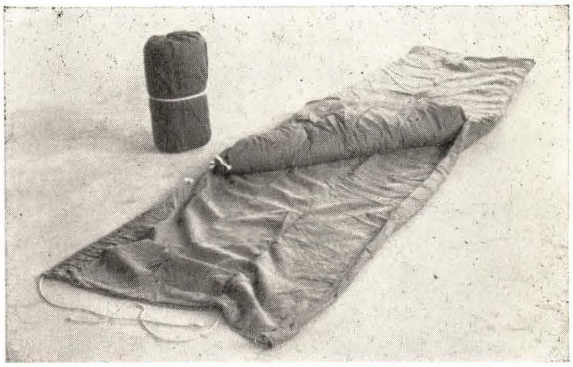


FIGURE N-2.—Goosedown sleeping bag.

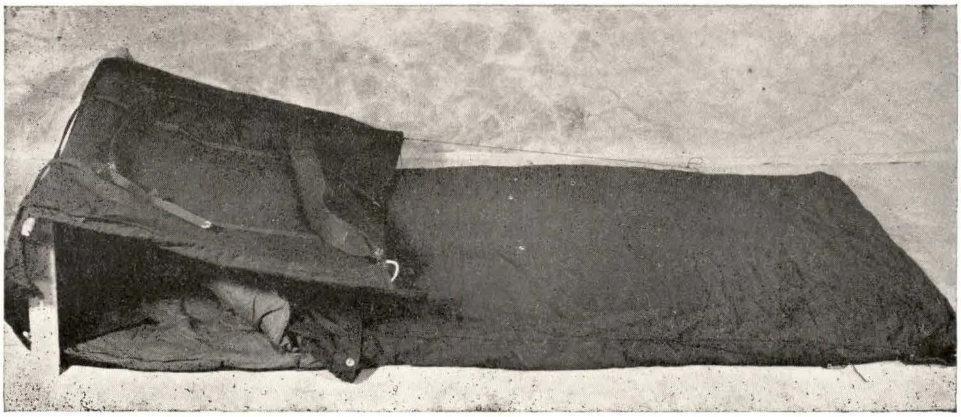


FIGURE N-1.—Kapok sleeping bag.

Note: Page N-2 and figures N-3 and N-4 are missing.

Stoves, Ranges, and Heaters

Stove, Camp, Kimmel.—A light, sturdily constructed, nestable stove for fire control and other camp requirements, adequate for a camp of 15 to 25 men (figs. N-5 and N-6). The stovepipe and collar nest in the oven, and the oven in the firebox, making a package approximately 29 by 19 by 13 inches. Cooking surface, 18 by 22 inches; oven 17 by 23½ by 11 inches; weight of stove, with three lengths of pipe, 100 pounds; approximate cost, $28.

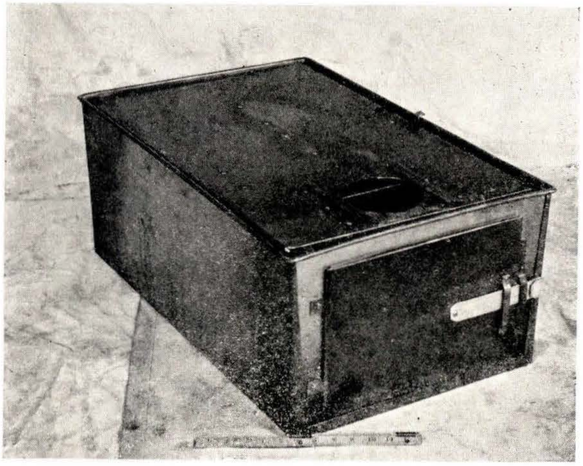


FIGURE N-5.—Kimmel camp stove nested for transporting.

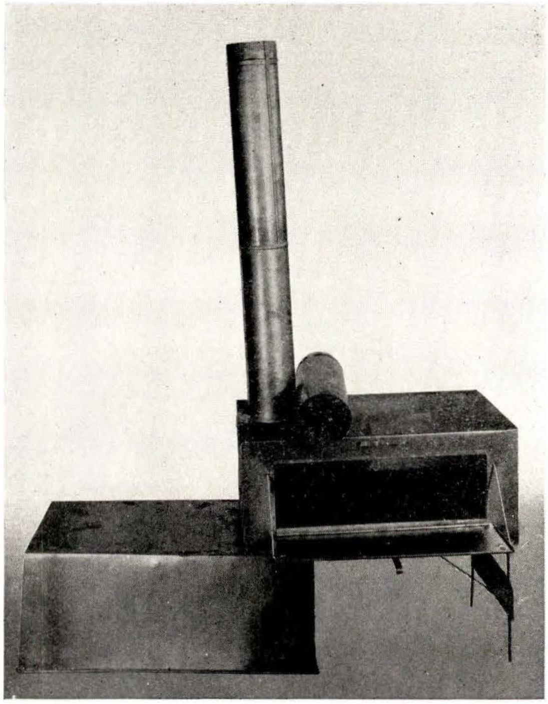


FIGURE N-6.—Kimmel camp stove ready for use.

An extra firebox to provide more cooking surface can be constructed a little larger than the regular firebox, so the standard stove will nest in it. This will add about 60 pounds weight and increase the cost about 50 percent if constructed of 18-gage material.

Range, Field, Liquid Gas.—This range, which uses commercial liquid gas, such as Flamo, Shellane, etc., was developed in Region 5. It is of all steel construction and can be dismantled readily and packed for transportation (fig. N-7). The standard assembly includes three five-burner units, one oven, and an octagonal-shaped hot water heater (fig. 8) which fits into the range oven for transportation. A large heavy cast-iron griddle (not shown), to fit the open-top five-burner unit, is optional.

The unit will provide adequate cooking facilities for a 250-man camp. Additional five-burner units may be connected if more capacity is needed, or one or two removed where smaller camps are the rule. In general, cooking facilities are improved and clean kitchens found where ranges of this type are used.

Where transportation facilities are available, this range can be used to advantage. The complete unit weighs approximately 600 pounds without the fuel tank and is, therefore, not convenient to pack to remote areas. The oven and three-burner units when assembled are about 105 inches wide by 25 inches deep.

	Weight (pounds)	*Approximate cost*
Oven unit, inside (Width, 25¾"; depth, 22"; height, 12". Height over-all, 46".)	178	$168
Five-burner unit (Width, 25"; depth, 24"; height, 31".)	96	63
Hot water heater (Width, 22"; depth, 22"; height, 9".)	65	54
Cast iron griddle (Width, 25"; depth, 24".)	17	13

Field tests show an average fuel consumption at normal operating pressure of 5 pounds per square inch, about 3¾ pounds per hour per five-burner unit, 3 pounds per hour for the oven, and 1¼ pounds per hour for the hot water heater. At an assumed average fuel cost of 4 cents per pound, the range can be operated with the oven and water heater (as illustrated) for about 62 cents per hour.

Suitable boxes have been designed for storage and transportation of the range and accessories.

Maintenance problems are negligible, and the unit will give continued uninterrupted service if the burners are kept clean and care is used in handling it.

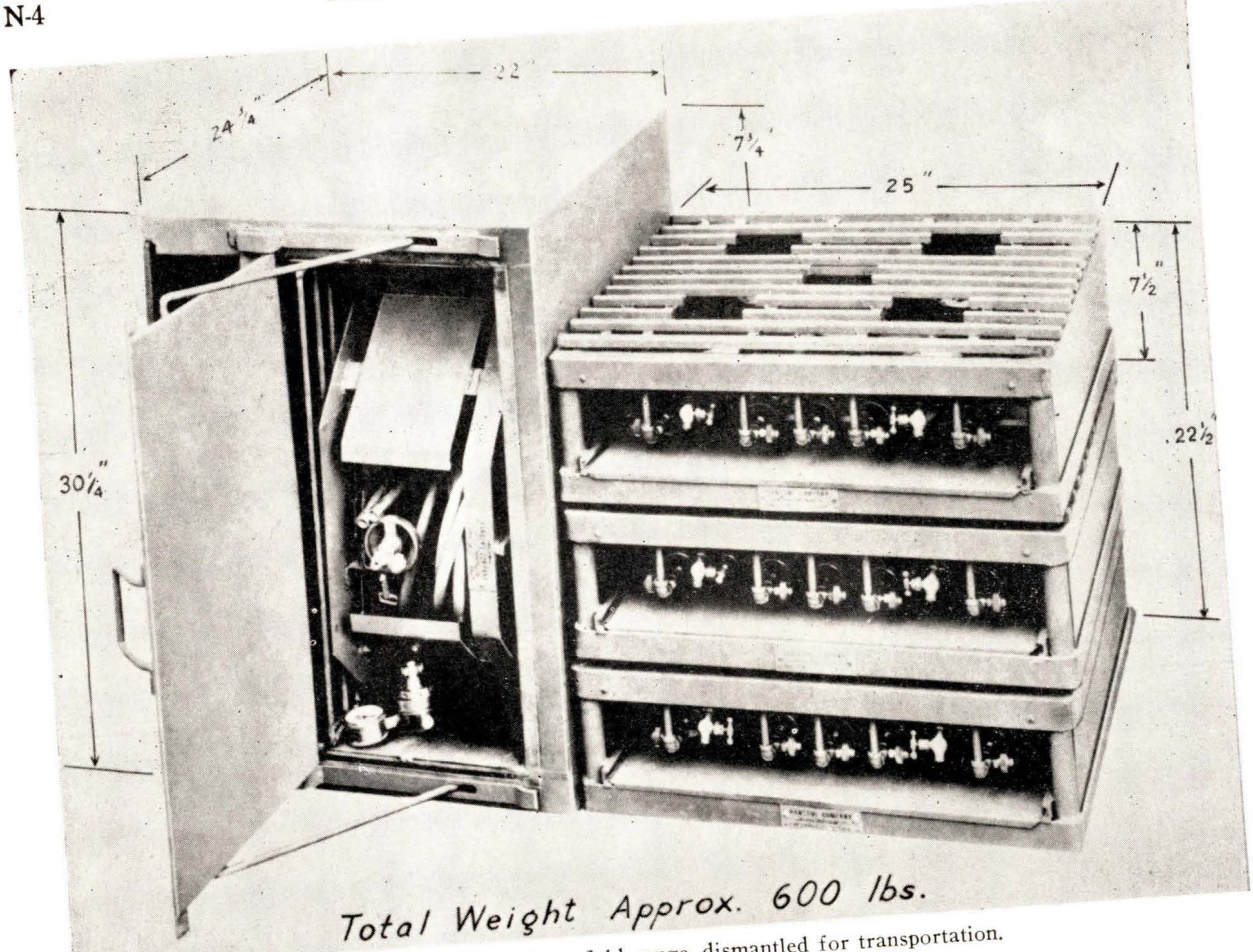

24¾"
22"
7¾"
25"
7½"
22½"
30¼"
Total Weight Approx. 600 lbs.

FIGURE N-7.—Liquid gas field range, dismantled for transportation.

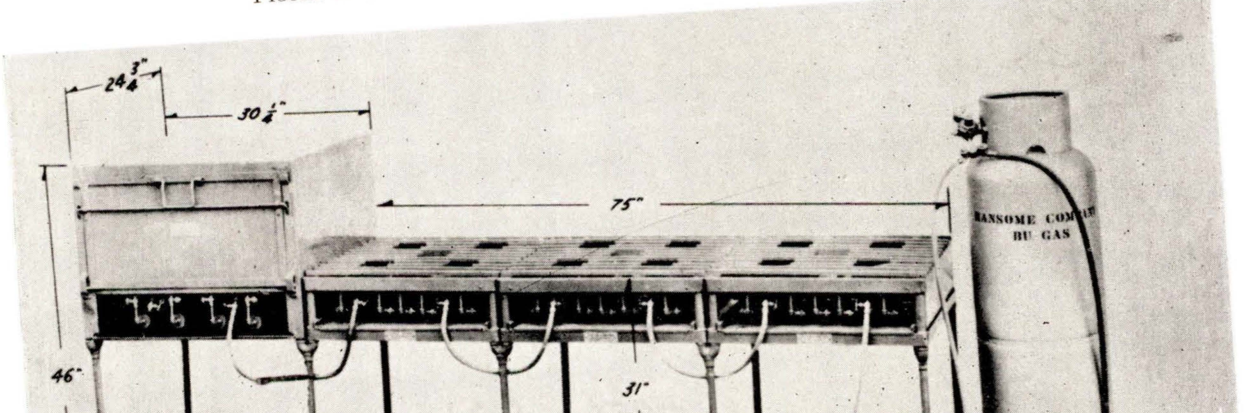

24¾"
30¼"
75"
ANSOME CO
BU GAS
46"
31"
9⅛"
22"
Unit Weight 96½ lbs
Weight 65 lbs

FIGURE N-8.—Liquid gas field range, assembled.

Heater, Water, Portable.—This heater (fig. N-9) was designed in Region 6 for heating water at fire camps, where wood fuel is available. Fed with bark, cones, or other burnable debris, or with pieces of wood, it will boil 60 gallons of water in 35 minutes.

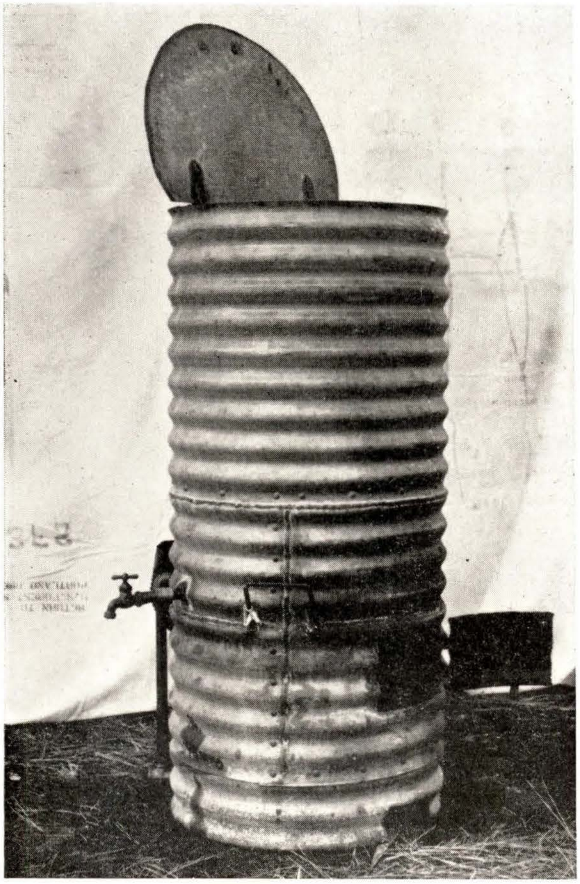


FIGURE N-9.—Portable water heater.

The tank and firebox are made of a single piece of corrugated galvanized iron culvert material 24 inches in diameter and 50 inches long, with a ⅛-inch steel plate welded in at a point 17 inches from one end to form the bottom of the tank and top of the firebox. A tank lid, fuel door, and draft opening are added, as shown. The circulating system requires from 27 to 30 feet of ¾-inch pipe. Circular coils are placed between the fuel door and the draft opening, and a flat coil above the fuel door. A faucet is provided for drawing hot water and another for draining the tank and coil. A 6-inch stovepipe collar is welded in at top rear of fire box. Approximate weight of heater, 100 pounds.

If desired, a gasoline drum can be used for the tank and a half drum for the firebox. A plan of the heater illustrated will be found at the back of this section.

Tables

Table Top, Canvas, Roll-Up.—A very satisfactory type of roll-up table top can be manufactured from canvas and lath (fig. N-10). The canvas is cut to the length of table desired and approximately 2 inches wider than the length of a standard lath. One inch of each edge is then folded under and the canvas securely tacked to lath sticks laid side by side, spaced approximately ¾ to 1 inch apart. The tacks should have large heads and be long enough to go through the lath and clinch slightly. They should be spaced according to the strength of the canvas used, usually about 3 to 4 inches apart. Figure N-10 illustrates clearly the manner of construction.

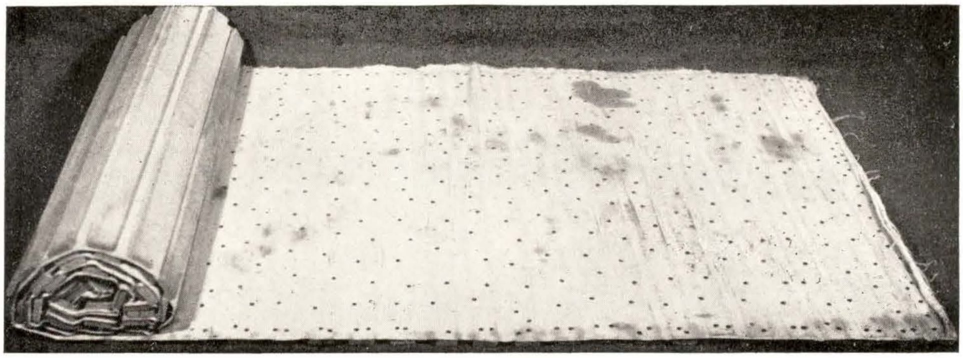


FIGURE N-10.—Roll-up table top.

Table-Top Ration Box.—Region 1 uses a combination table-top ration box in which to transport fire rations (fig. N-11). The box provides between 3 and 4 cubic feet of space and is held together with ordinary metal box strapping. After the rations reach the fire camp or other location where they are to be used, the box can easily be opened and made into a table top approximately 30 inches wide and 7 feet long. A plan of this box will be found at the end of this section.

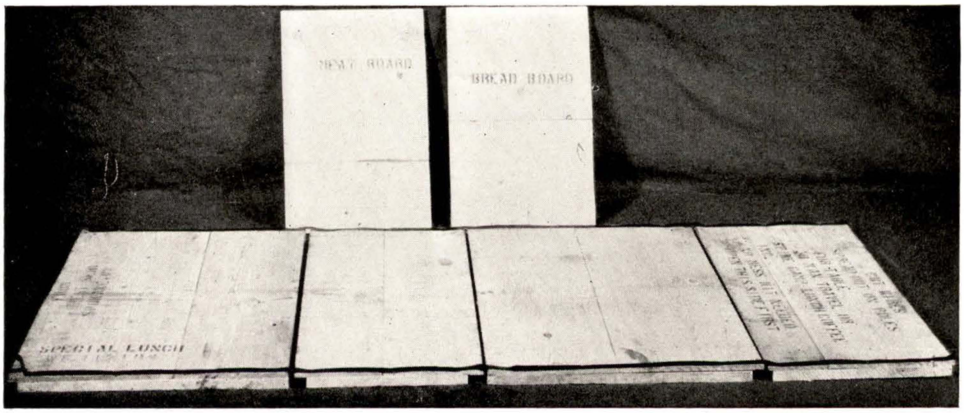


FIGURE N-11.—Table-top ration box.

Table, Camp, Folding.—The table shown in figure N-12 is easy to construct, is rigid when set up, and can be folded compactly and secured with two hooks. The shelf near the bottom serves as storage space and increases the sturdiness of the table. The crosspieces at the end of the shelf keep it in place when the table is either set up or folded.

The table top and shelf can be made of plywood, as shown, or of 1-inch lumber, S4S. Other parts are made of 1- by 4-inch and 1- by 6-inch lumber, S4S. Plywood for the shelf should be ¾-inch, but ½-inch is heavy enough for the top. Legs should be 1- by 6-inch lumber, but crosspieces and braces may be 1- by 4-inch. Hinges are 3¼-inch butt by 6-inch strap and are used at top of each leg and at top and bottom of each brace. The pin is removed from the hinges at top of braces, and loose pins are secured with short pieces of wire or chain to prevent loss. The table is put together with ¼-inch rivets or bolts, instead of nails or screws.

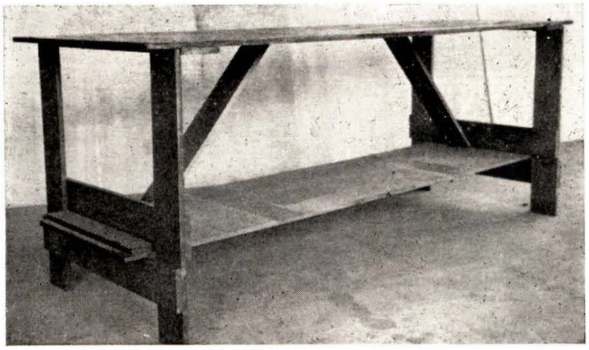
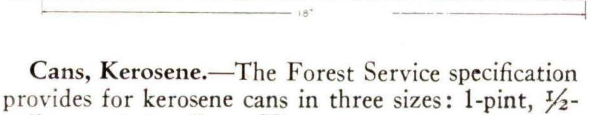


FIGURE N-12.—Folding camp table.

The dimensions of a table of this kind will depend on the use to be made of it. For cafeteria tables, 38-inch legs and a 30- by 96-inch top are recommended. For a kitchen work table, an overall height of 36 inches is preferable. The same design may be used for office or dining tables, with the standard height of 30 inches. See plan at the end of this section.

Sign, Fire-Camp, Directional.—The drawing below shows a reflector sign, which is needed where fire camps are serviced at night. The arrow is cut from reflector material, red wide-angle "Scotchlite" or equal, and glued to the sign, which has been printed on heavy cardboard, with the special adhesive furnished by the manufacturer. The material will reflect satisfactorily the light from automobile or other lamps when approaching at approximately right angles. Estimated cost of the completed sign is 30 cents.



Cans, Kerosene.—The Forest Service specification provides for kerosene cans in three sizes: 1-pint, ½-gallon, and 1-gallon. These are rectangular cans, with slightly rounded corners and screw tops, which are leakproof. The 1-pint size is particularly useful for carrying oil to use on saws in felling and bucking operations. It is the proper size and shape to fit into the hip pocket. The larger cans are used principally for transporting fuel and lubricating oils for lanterns and portable power equipment.

Nested Cooking and Mess Outfits

Nested cooking and mess outfits have been developed over a period of several years, particularly for use in fire control, to provide adequate equipment, compact in form and of minimum weight, for various sized crews. Items of special manufacture have been designed, as far as possible, to make them interchangeable in the different outfits.

With transportation facilities and the trend of fire-suppression activities such that interregional exchange of fire control equipment is of common occurrence, the need for standardization of nested mess equipment is obvious. It is particularly essential in Regions 1, 4, 5, and 6, where interregional exchanges of these outfits are frequent. Unless the outfits and their contents are standard, confusion and difficulties occur.

The following sizes in mess outfits have been adopted as standard for the Forest Service, and standard lists of contents have been prepared to facilitate their use. Specifications have also been prepared for most of the individual items. Items used in other than standard outfits should be standard wherever practicable.

Standard sized outfits.—1-, 2-, 3-, 6-, 10-, and 25-man. In addition, two types of 50-man outfits, made up of standard items, are suggested for use where larger outfits are required.

Standard lists of contents.—The number of individual items listed as standard in any particular outfit may be modified for local use provided standard items are used where increases are made.

Outfit-Mess, 1-Man.—Individual camp cooking outfit, complete with carrying case and shoulder strap and the following items:

1 Pan, aluminum, pudding, 7¼ inches in diameter, 1½ inches deep, 1½-pint capacity.
1 Pail and cover, aluminum, 5 inches in diameter, 2⅝ inches deep, 1¾-pint capacity.
1 Fork, tinned steel.
1 Spoon, tinned steel.
1 Pan, fry, with folding handle.
1 Cup, aluminum, 4 inches in diameter, 2 5/16 inches deep, ¾-pint capacity.

All articles to nest and pack between frying pan and pudding pan. Handle of frying pan to fit snugly over pudding pan and to hold outfit together securely. To be equal in every respect to the Aluminum Cooking Utensil Company's No. 1016. Approximate cost, $1.25.

Outfit, Mess, 2-Man. (Fig. N-13).—

1 Container, canvas.
1 Pan, fry, 9-inch.
1 Pail, aluminum, with cover, 4-quart, Wear-ever, No. 877.
1 Pail, aluminum, with cover, 6-quart, Wear ever, No. 878.
1 Pan, 3-quart, tin.
2 Pans, 1-quart, tin.
1 Pot, coffee, aluminum.
2 Plates, tin.
2 Cups, tin, 1-pint.
2 Knives, table.
2 Forks, table.
1 Spoon, dessert.
2 Teaspoons.
1 Knife, butcher, folding.
1 Knife, paring.
1 Opener, can.
1 Peeler, potato.

Approximate cost, $6.75.

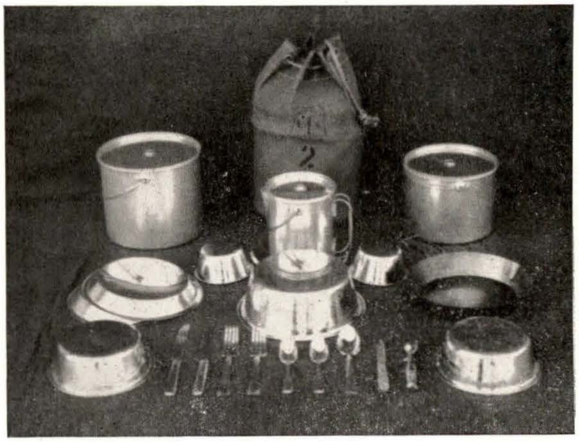


FIGURE N-13.—Nested mess outfit, 2-man.

Outfit, Mess, 3-Man. (Fig. N-14).—

1 Container, canvas.
2 Pans, fry, 9-inch.
1 Pail, aluminum, with cover, 4-quart, Wear-ever, No. 877.
1 Pail, aluminum, with cover, 6-quart, Wear-ever, No. 878.
1 Pan, tin, 3-quart.
3 Pans, tin, 1-quart.
1 Pot, coffee, aluminum
3 Plates, tin.
3 Cups, tin, 1-pint.
3 Knives, table.
3 Forks, table.
2 Spoons, dessert.
3 Teaspoons.
1 Knife, paring.
1 Knife, butcher, folding.
1 Opener, can.
1 Peeler, potato.

Approximate cost, $7.75.

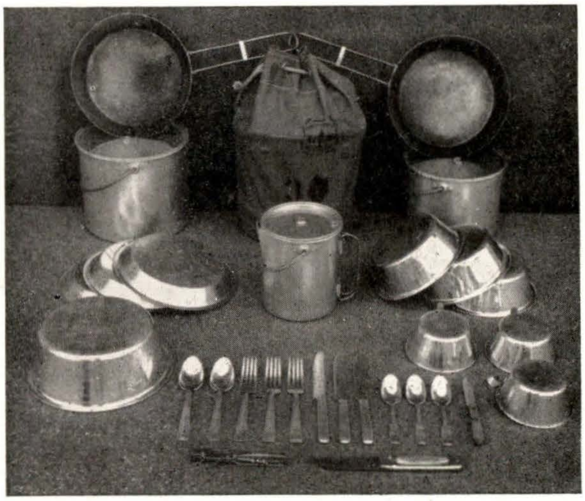


FIGURE N-14.—Nested mess outfit, 3-man.

Outfit, Mess, 6-Man. (Fig. N-15).—

- 1 Container, canvas.
- 1 Pail, aluminum, with cover, 4-quart, Wear-ever, No. 877.
- 1 Pail, aluminum, with cover, 6-quart, Wear-ever, No. 878.
- 1 Pail, aluminum, with cover, 8-quart, Wear-ever, No. 880.
- 6 Cups, tin, 1-pint.
- 8 Spoons, dessert.
- 8 Forks, table.
- 1 Pail, aluminum, with cover, 9-quart, Wear-ever, No. 881.
- 3 Pans, fry, 10-inch.
- 3 Pans, tin, 2-quart.
- 8 Pans, tin, 1-quart.
- 8 Plates, tin.
- 8 Knives, table.
- 1 Knife, paring.
- 1 Knife, butcher, folding.
- 1 Stone, ax.
- 1 Opener, can.
- 4 Chains, kettle.
- 1 Clock, alarm.
- 1/3 Pound nails, sixpenny and twenty-penny.
- 2 Towels, dish, cloth.
- 2 Towels, hand, cloth.
- 1 Lifter, pot.
- 1 Peeler, potato.

Approximate cost, $13.50.

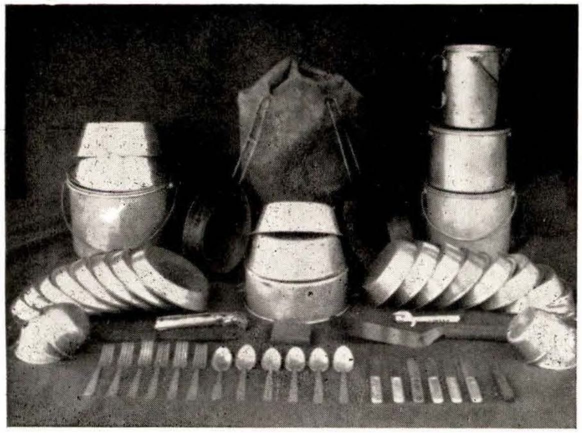


FIGURE N-15.—Six-man nested mess outfit.

Outfit, Mess, 10-Man. (Fig. N-16).—

- 1 Container, tin.
- 1 Pail, aluminum, with cover, 8-quart, Wear-ever, No. 880.
- 1 Pail, aluminum, with cover, 9-quart, Wear-ever, No. 881.
- 1 Pail, aluminum, with cover, 11-quart, Wear-ever, No. 882.
- 1 Pail, aluminum, with cover, 14-quart, Wear-ever, No. 883.
- 2 Pans, fry, 10-inch.
- 2 Pans, fry, 12-inch.
- 3 Pans, pudding, 3-quart, tin.
- 14 Plates, tin.
- 12 Cups, tin, 1-pint.
- 1 Spoon, basting, 10-inch.
- 14 Spoons, dessert
- 12 Forks, table.
- 12 Knives, table.
- 1 Knife, paring.
- 1 Knife, butcher, 8-inch.
- 1 Stone, ax.
- 1 Opener, can.
- 4 Chains, kettle.
- 1 Clock, alarm.
- ½ Pound nails, tenpenny and twenty-penny.
- 3 Towels, dish, cloth.
- 3 Towels, hand, cloth.
- 1 Lifter, pot.
- 1 Peeler, potato.

Approximate cost, $21.

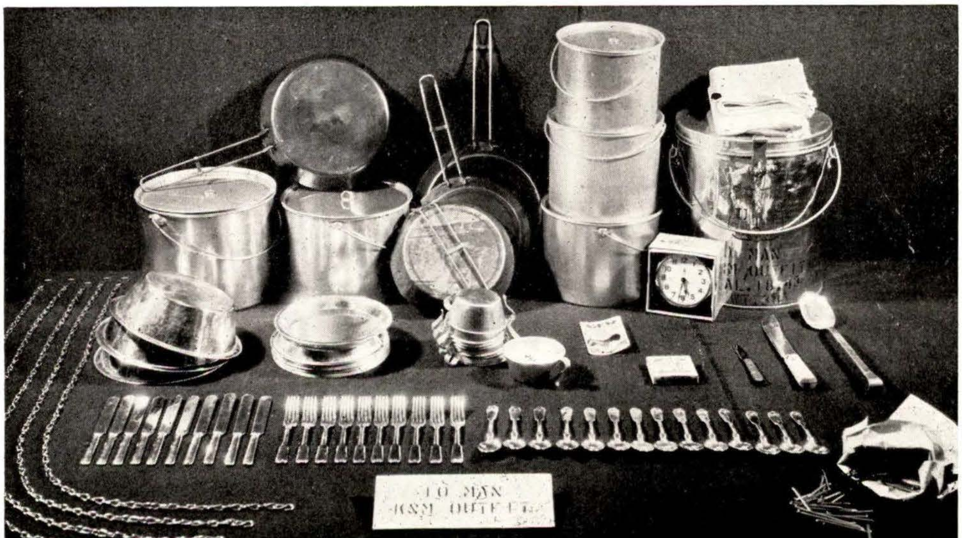


FIGURE N-16.—Ten-man nested mess outfit.

Outfit, Mess, 25-Man. (Fig. N-17).—

1 Container, 25-man, galvanized, iron.
1 Cover, for 25-man container.
2 Pans, half-oval, tin.
2 Pails, half-oval, and covers, tin.
1 Box, knife and fork, tin.
1 Pail, tin, 6-quart, 8 inches diameter, 10½ inches deep, with cover.
1 Pail, tin, 9-quart, 8½ inches diameter, 11 inches deep, with cover.
1 Pail, tin, 13-quart, 9 inches diameter, 11½ inches deep, with cover.
1 Pail, tin, 16-quart, 9½ inches diameter, 12 inches deep, with cover.
2 Pans, fry, 12-inch.
30 Pans, tin, 1-quart.
12 Pans, tin, 3-quart.
4 Pans, enamel, 3-quart.
30 Plates, tin.
30 Cups, tin, 1-pint.
30 Knives, table.
30 Forks, table.
30 Spoons, dessert.
12 Tablespoons.
2 Spoons, basting, 13½-inch.
1 Fork, meat.
1 Knife, butcher, 10-inch.
1 Knife, butcher, 8-inch.
2 Knives, paring.
2 Lifters, pot.
1 Masher, potato.
3 Openers, can.
1 Turner, cake.
1 Whip, egg.
6 Chains, kettle.
1 Clock, alarm.
2 Files, 8-inch, mill bastard.
50 bags, lunch, cellophane.
30 Sacks, lunch, cloth.
1 Stone, ax.
10 Towels, dish, cloth.
150 Towels, paper.
2 Pounds nails, twentypenny.
2 Pounds nails, forty-penny.
1 Brush, pastry, 2-inch.
4 Soap, hand.
4 Soap, laundry.
2 Peelers, potato.

Approximate cost, $52.

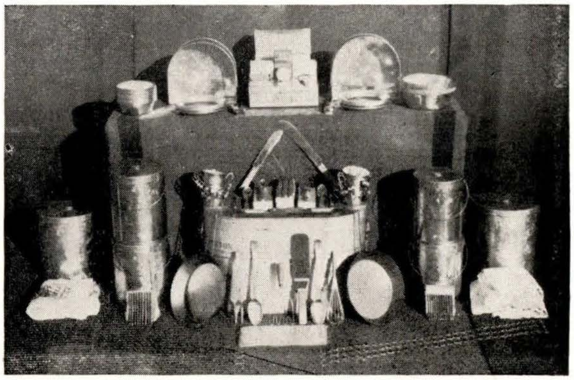


FIGURE N–17.— Twenty-five-man nested mess outfit.

Box, Mess-Equipment, Auxiliary. (Fig. N–18).— In Region 1, a wooden box, containing the mess and camp equipment listed below, is used to supplement the standard 25-man outfit.

1 Dishpan, 21-quart.
2 Funnels, filter-type.
3 Generators, gas-lantern.
1 Hammer, claw.
2 Lanterns, gasoline.
24 Mantles, gas-lantern.
1 Mosquito bar.
2 Pans, fry.
1 Saw, meat.
25 Towels, hand, cloth.
4 Basins, wash.
4 Buckets, canvas.
1 Wrench, lantern.
2 Gallons gasoline (separate container).

Approximate cost, $22.

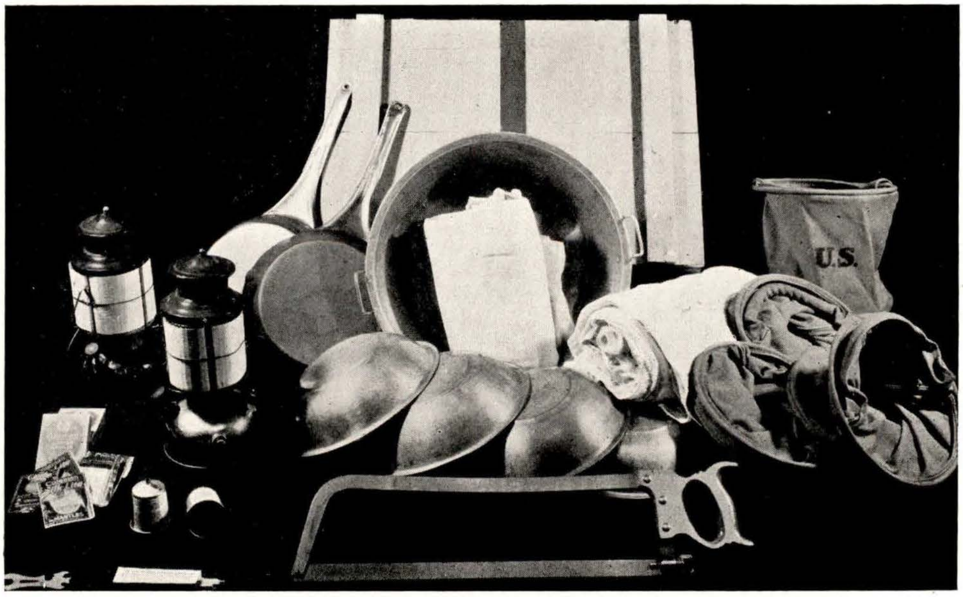


FIGURE N–18.— Region 1 twenty-five-man auxiliary mess box.

Outfit, Mess, 50-Man (Region 5). (Fig. N–19).—In Region 5, a 50-man nested mess outfit is assembled by using two metal containers and other standard equipment listed as follows:

Contents—Unit No. 1

1 Container, 25-man.
1 Cover, for 25-man container.
2 Pans, tin, half-oval.
2 Pails, tin, half-oval, with cover.
2 Pails, tin, round, 9 inches by 11½ inches, with cover.
1 Pail, tin, round, 8½ inches by 11 inches, with cover.
1 Pail, tin, round, 8 inches by 10½ inches, with cover.
1 Box, tin, knife and fork.
2 Openers, can.
54 Cups, tin, 1-pint.
54 Knives, table.
54 Forks, table.
1 Knife, butcher, 8-inch blade.
1 Knife, butcher, 10-inch blade.
2 Knives, paring.
2 Lifters, pot.
54 Pans, tin, 1-quart.
60 Plates, tin, 9-inch.
54 Spoons, dessert.
12 Tablespoons.
12 Towels, hand, cloth.
12 Towels, dish, cloth.

Contents—Unit No. 2

1 Container, 25-man.
1 Cover, for 25-man container .
3 Buckets, canvas.
5 Basins, wash, tin.
1 Whip, egg.
1 Fork, meat.
1 Hatchet, claw.
6 Knapsacks, white.
2 Ladles, soup.
50 Bags, lunch, cellophane.
3 Pounds nails, sixpenny.
3 Pounds nails, tenpenny.
3 Pounds nails, twentypenny.
4 Pans, fry, 12-inch.
4 Pans, bake, 20 inches by 11½ inches by 2½ inches.
5 Pans, tin, 4-quart.
5 Pans, tin, 3-quart.
150 Towels, paper.
3 Spoons, basting, 13½-inch.
1 Stone, ax.
1 Saw, butcher.
1 Turner, cake.
4 Peelers, potato.

Approximate cost, $90.

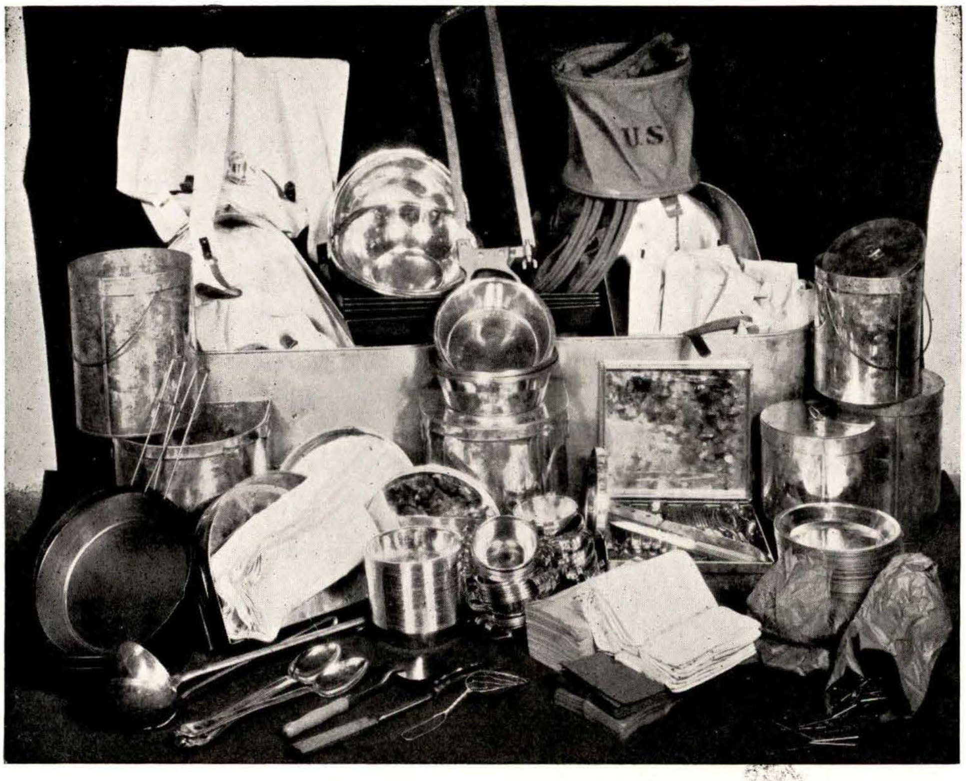


FIGURE N–19.— Fifty-man nested outfit — Region 5.

Outfit, Mess, 50-Man (Region 1). (Fig. N-20).—

In Region 1, to provide a 50-man mess outfit, the Region 1 25-man outfit as heretofore described is augmented with an additional metal container in which the following standard equipment is packed:

2 Pails, tin, half-oval.
25 Pans, 1-quart, tin.
25 Cups, tin.
25 Forks, table.
25 Knives, table.
25 Plates, tin.
25 Spoons, dessert.
25 Towels, hand .
4 Pans, 3-quart, tin.
25 Bags, cloth, lunch.
50 Bags, cellophane.
8 Headlights, electric.*
48 Batteries, dry-cell.*
2 Knapsacks (packsacks).*
2 Bags, water, man-pack.*

* Packed with the mess outfit for convenience in transporting complete fire-equipment units.

Approximate cost, $45.

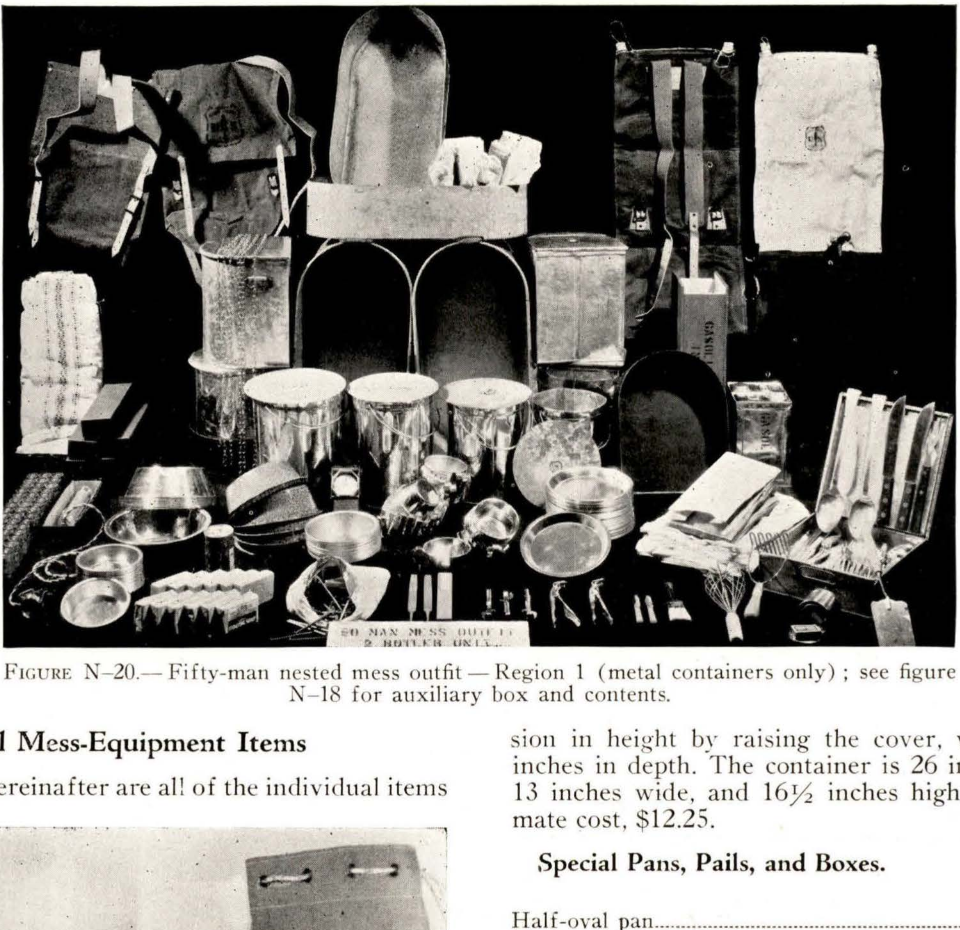


FIGURE N–20.— Fifty-man nested mess outfit — Region 1 (metal containers only); see figure N–18 for auxiliary box and contents.

Individual Mess-Equipment Items

Listed hereinafter are all of the individual items of mess equipment, standard and otherwise, which are contained in the various outfits described hereinbefore.

Containers

Container, 2-, 3-, and 6-Man Outfits (Fig. N–21).—Constructed of khaki duck. Approximate cost, 2- or 3-man, 72 cents; 6-man, 94 cents.

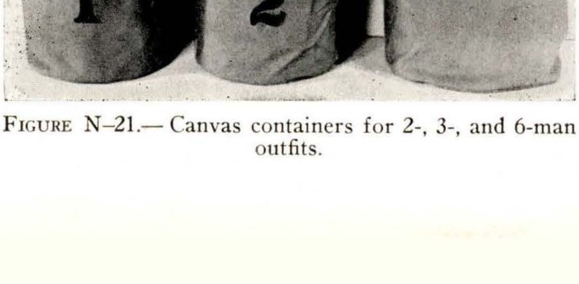


FIGURE N–21.— Canvas containers for 2-, 3-, and 6-man outfits.

Container, 10-Man Outfit.—Constructed of XXXX charcoal tin; dimensions, 14 inches high by 12⅜ inches in diameter (fig. N-16). Approximate cost, $3.60.

Container, 25- and 50-Man Outfit.—Constructed of galvanized iron or sheet metal and heavily retinned, as required (fig. N–17). Container has adjustable chain fasteners to allow a 5-inch extension in height by raising the cover, which is 7 inches in depth. The container is 26 inches long, 13 inches wide, and 16½ inches high. Approximate cost, $12.25.

Special Pans, Pails, and Boxes.

	Cost
Half-oval pan	$1.81
Half-oval pail and cover	3.68
Round tin pails and covers (nestable)	
Aluminum pails and covers (nestable)	
Knife and fork box, 25- and 50-man	3.68

The half-oval pans and pails are constructed of XXXX charcoal tin. The round tin pails are constructed with XXXX charcoal tin bottoms and XXX charcoal tin sides. All tin covers are made of XXX charcoal tin. Only one size of half-oval pans and half-oval pails and four sizes of round tin pails are available.

The aluminum pails and covers are of the Wear-ever type, seamless construction. Refer to figure

N-22 and the table of dimensions given below for further details. The half-oval pan and pail are illustrated in figure N–17.

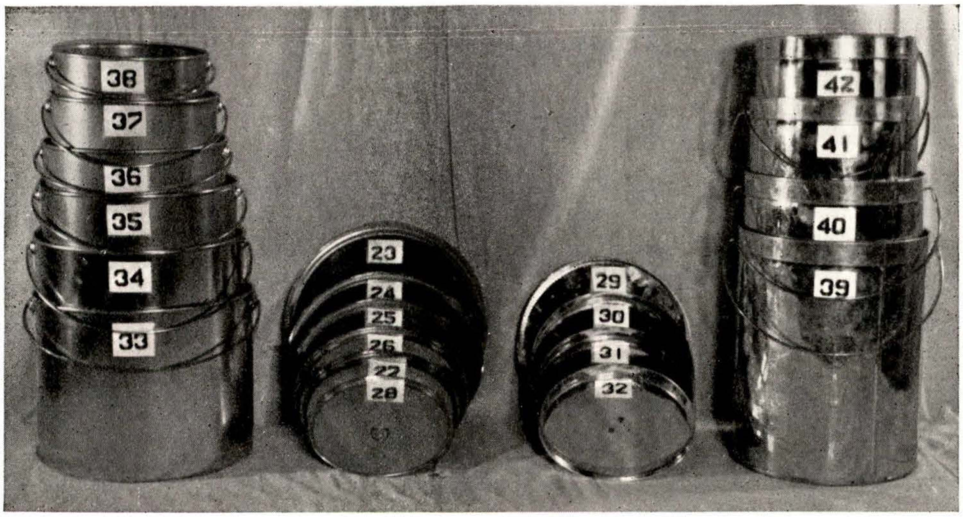


FIGURE N–22.— Tin and aluminum pails and covers.

The 25- and 50-man knife and fork box is constructed of XXXX charcoal tin. It is also illustrated in figure N–17.

The following table gives the illustration reference numbers of the individual nestable pails and covers shown in figure 22, and the capacity and dimensions of each:

Aluminum Ware

Reference No. Pail	*Reference No.* Cover	Capacity *Quarts*	Diameter *Inches*	Depth *Inches*	Quality	Approximate Cost
33	23	14	11	8⅝	Wearever No. 883	$2.05
34	24	11	10⅜	8	Wearever No. 882	1.91
35	25	9	9⅝	7¼	Wearever No. 881	1.58
36	26	8	9	7½	Wearever No. 880	1.48
37	27	6	8⅛	6⅞	Wearever No. 878	1.12
38	28	4	7¼	5½	Wearever No. 877	.92

Tinware

39	29	16	9½	12		$1.57
40	30	13	9	11½		1.54
41	31	9	8½	11		1.54
42	32	6	8	10½		1.52

Coffee Pots, Baking and Frying Pans (Fig. N-23)

Pans, Baking or Drip.—To be made of pressed steel, 27-gage, tapered sides and ends. Upper edge to be lapped over a No. 9 copper-clad iron wire. Loop handles of No. 9 wire on each end. Dimensions may be varied to suit local conditions. A pan 11½ inches wide, 20 inches long at the top, and 2½ inches deep will fit the Region 5, 50-man outfit. (Fig. N-23, items 17 and 18.) Approximate cost, $1.03.

Pans, Frying, Folding Handle—To be of 22-gage, smooth steel, with folding handle. Similar in design and workmanship to the folding-handle skillet manufactured by the United Steel & Wire Co., Battle Creek, Mich. To be of the following approximate dimensions:

Diameter at top	*Diameter at bottom*	*Depth*	*Approximate price*
9 inches	7 inches	2 inches	38 cents
10 inches	8 inches	2 inches	38 cents
12 inches	10 inches	2 inches	46 cents

(Fig. N–23, items 19, 20, 21.)

Pot, Coffee, Aluminum.—Five inches in diameter, 7⅛ inches deep, with folding handle, hinged lid, and bail, capacity 2¼ quarts, equal in material and workmanship to that sold under the Wear-ever brand. (Fig. N-23, item 22.) Approximate cost, $1.80.

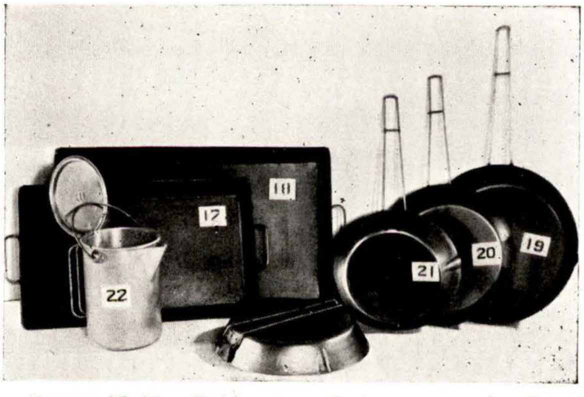


FIGURE N–23.— Baking pans, frying pans, and coffee pot.

PUDDING PANS, PLATE, AND CUP (Fig. N–24)

Pans, Pudding, Granite, 3-quart.—Granite, seamless, deep pattern; top diameter 9¼ inches, depth 3 inches; capacity approximately 3 quarts. (Fig. N-24, item 46.)

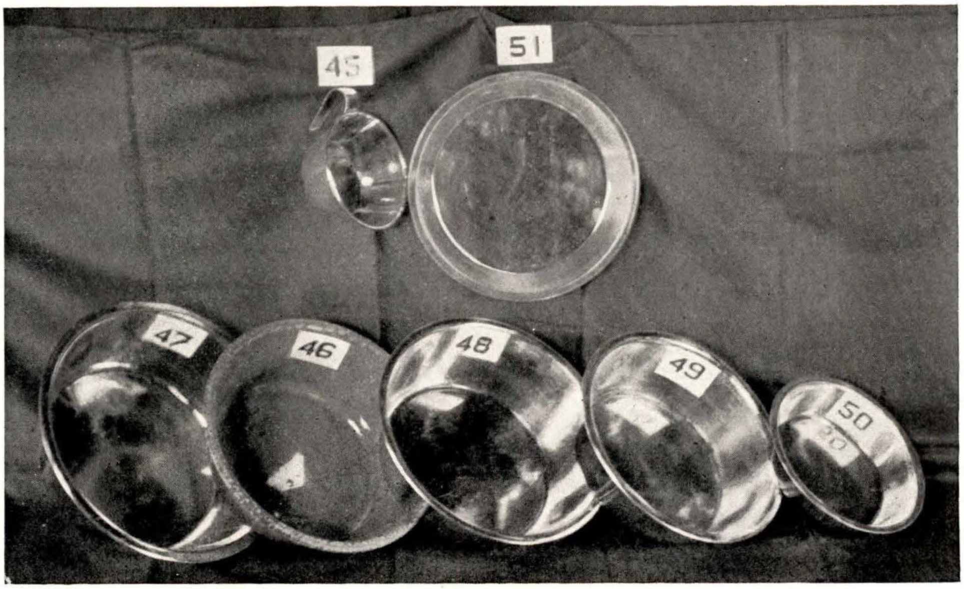


FIGURE N–24.— Pudding pans, plate, and cup.

Tin Pans.—To be IC retinned and of the following dimensions and approximate capacity:

Capacity *Quarts*	Top Diameter *Inches*	Depth *Inches*	Approximate Cost *Cents*
4	10¼	3¼	15
3	9¼	3¼	13
2	8½	3	13
1	7¼	2⅜	13

(Fig. N-24, items 47, 48, 49, 50.)

Plate, Tin.—IC tin, outside top dimension, 9 inches, and from 1 to 1¼ inches deep. (Fig. N-24, item 51.) Approximate cost, 5 cents.

Cup, Tin.—No. 2 California or miner's pattern, 4⅝ inches across the top outside, 2⅛ inches deep, approximate capacity 1 pint, to be IC retinned, seamless material with handle riveted at the top and open at the bottom to allow nesting. (Fig. N–24, item 45.) Approximate cost, 11 cents.

KNIVES, FORKS, SPOONS, AND MISCELLANEOUS ITEMS

Knife, Butcher, Plain.—Blade of first-quality steel well ground on cutting edge, handle to be riveted with either steel or brass rivets, Universal No. 1213 or equal. Length of blade 8 or 10 inches, as required. Approximate cost, 8-inch, 19 cents; 10-inch, 33 cents.

Knife, Butcher, Folding-Blade. — Dimensions, design, and materials similar and equal to Marble's safety fish knife No. 78. Approximate cost, 77 cents.

Knife, Paring.—Blade 3 to 3½ inches long, of fine-grade steel; steel-riveted beechwood handle; length over-all not to exceed 6½ inches. Approximate cost, 6 cents.

Knife, Table.—Iron or steel, heavily retinned, weight per dozen 2¼ pounds. Approximate cost, 6 cents.

Fork, Meat. — Two-pronged; riveted wood handle; length over-all 12½ inches; weight per dozen, approximately 3 pounds. Approximate cost, 20 cents.

Fork, Table.—Iron or steel, heavily retinned, four-pronged, weight per gross, 12 pounds, Wallace Bros., No. 802 or equal. Approximate cost, 3 cents.

Spoon, Basting or Stirring.—Forged steel, retinned, eyelet in handle, length over-all 10 or 13½ inches, as required. Approximate cost 10-inch, 9 cents; 13½-inch, 11 cents.

Tablespoon.—Iron or steel, heavily retinned, weight not less than 13 pounds nor more than 15 pounds per gross. Wallace Bros., No. 802 or equal. Approximate cost, 3 cents.

Spoon, Dessert.—Iron or steel, heavily retinned, weight not less than 10 pounds nor more than 12 pounds per gross, Wallace Bros., No. 802 or equal. Approximate cost, 3 cents.

Teaspoon. — Iron or steel, heavily retinned, weight not less nor more than 8 pounds per gross. Wallace Bros., No. 802 or equal. Approximate cost, 2 cents.

Ladle, Soup.—Solid, retinned, top diameter 4 inches, weight per dozen 4 pounds. Approximate cost, 10 cents.

Lifter, Pot.—Forged steel, heavily retinned, approximately 8 inches long, similar to Aluminum

Cooking Utensil Co., No. 159. Approximate cost, 21 cents.

Masher, Potato.—Wire, retinned, face 3 by 3⅛ inches, length over-all, 9½ inches, weight, approximately 4½ pounds per dozen. Approximate cost, 9 cents.

Turner, Cake.—Straight offset flexible blade with upper edge sharpened for cutting or chopping food, left edge blunt for turning food; beech handle with brass compression rivets; approximately 9 inches long, 3 inches wide. Approximate cost, 67 cents.

Brush, Pastry.—Flat 2-inch varnish brush, Federal Stock Catalog No. 38-B-5140. Approximate cost, 35 cents.

Opener, Can.—Combination can opener and corkscrew, all-steel frame, Yankee pattern. Approximate cost, 3 cents.

Whip, Egg.—French style, tinned wire, wire-bound handle, five bows, length 12 inches, weight, approximately 3¾ pounds per dozen. Approximate cost, 29 cents each.

Chains, Kettle.—Length 3 feet, 13-gage twist link, bright-finished coil chain, with 10-gage S-hook, 2 inches long, on each end. To be packed in bundles of 25 each with hook ends wrapped with burlap or other material to prevent tangling in shipment. Approximate cost, 7 cents.

Saw, Meat. — Butcher saw, protected steel frame, 18-inch detachable blade. Approximate cost, $1.25.

Bag, Lunch, Cellophane.—Transparent, square type, 6 inches wide, 3½-inch bellows, 13 inches long, to be made of No. 450 plain cellophane or of a material similar and equal thereto. Approximate cost, $1.27 per C.

Washbasin.—Retinned, diameter approximately 12¼ inches. Approximate cost, 10 cents.

Dishpan.—Charcoal plated, retinned IXX, capacity 17 quarts, size 17¾ by 5¾ inches, weight 27 pounds per dozen. Approximate cost, $1.

Toweling, Dish.—When obtainable, misprint flour sacks make satisfactory and economical dish towels. Unbleached sheeting, Federal Specification No. CCC–S–281, type B, 36 inches wide, is also recommended. Approximate cost, 11 cents.

Towels, Hand, Cloth.—Huck, Federal Specification DDD–T–531. Approximate cost, 17 cents.

Towels, Hand, Paper.—Flat, 50 percent sulphite and 50 percent ground wood, 32-pound weight, junior size (10¾ by 11 inches), 150 to package. Approximate cost, 8 cents per package.

Stone, Ax.—(Refer to Sec. Q, Sharpening Equipment.) Approximate cost, 50 cents.

Bag, Water, Man-pack.—(Refer to Sec. G, Water Equipment.) Approximate cost, $1.80.

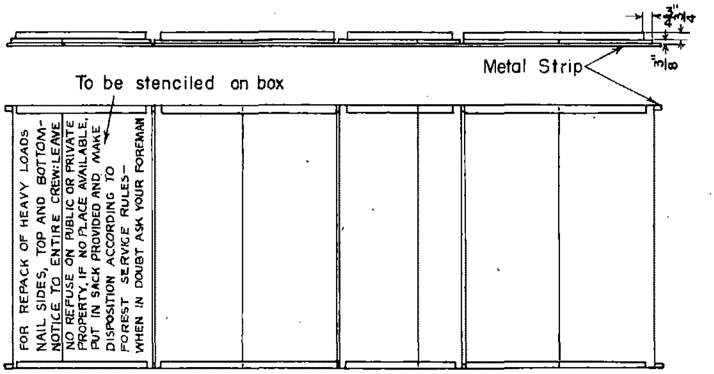
Clock, Alarm.—Similar in size and design and equal as to materials, workmanship, and dependability to the Junior Tattoo as manufactured by the New Haven Clock Co. Approximate cost, $1.75.

Knapsack (Packsack). — (Refer to Sec. H, Packing Equipment.) Approximate cost, $2.

Bag, Cloth, Lunch.—Bag to be manufactured from unbleached cotton sheeting, in accordance with Federal Specification No. CCC–S–281, table 1, type C, as amended. Sheet, size 18 by 21 inches, to be folded double and sewed one side and bottom, then turned to form bag. Sewing to be done with three-ply No. 12 thread in the needles and two-ply No. 12 thread in the looper. Selvage top, not hemmed. Finished size approximately 10 by 17 inches. Approximate cost, 3 cents.

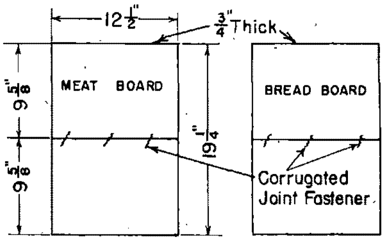
Bucket, Canvas.—A canvas bucket approximately 14 inches in diameter by 14 inches in depth. Top and bottom hems are strengthened with a heavy wire ring. It has a rope-inserted handle. The bucket is similar to the Army-type bucket. Approximate cost, 60 cents.

Cans, Milk, 5- and 10-gallon.—(Refer to Sec. G, Water Carrying Equipment.) Approximate cost, 5-gallon, $5; 10-gallon, $7.



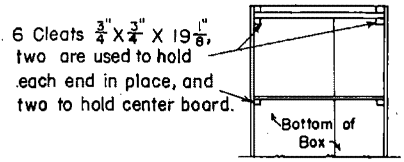
3/4"
3/8"
Metal Strip
To be stenciled on box
FOR REPACK OF HEAVY LOADS
NAIL SIDES, TOP AND BOTTOM-
NOTICE TO ENTIRE CREW: LEAVE
NO REFUSE ON PUBLIC OR PRIVATE
PROPERTY, IF NO PLACE AVAILABLE,
PUT IN SACK PROVIDED AND MAKE
DISPOSITION ACCORDING TO
FOREST SERVICE RULES—
WHEN IN DOUBT ASK YOUR FOREMAN

INSIDE VIEW OF UNFOLDED BOX



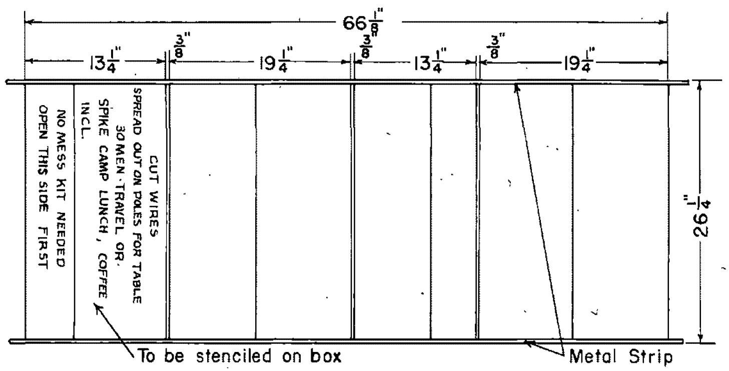
12 1/2"
3/4" Thick
9 5/8"
9 5/8"
19 1/4"
MEAT BOARD
BREAD BOARD
Corrugated Joint Fastener

BOX ENDS
Used for meat and bread boards



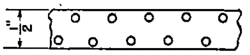
6 Cleats 3/4" X 3/4" X 19 1/8",
two are used to hold
each end in place, and
two to hold center board.
Bottom of Box

VIEW SHOWING END CONSTRUCTION
Looking down from top



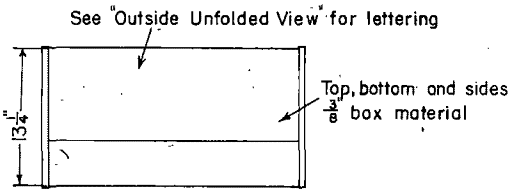
66 1/8"
13 1/4"
3/8"
19 1/4"
3/8"
13 1/4"
3/8"
19 1/4"
26 1/4"
OPEN THIS SIDE FIRST
NO MESS KIT NEEDED
CUT WIRES
SPREAD OUT ON POLES FOR TABLE
30 MEN · TRAVEL OR
SPIKE CAMP LUNCH, COFFEE
INCL.
To be stenciled on box
Metal Strip

OUTSIDE VIEW OF UNFOLDED BOX



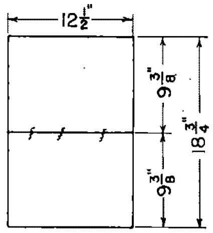
METAL STRIP OR BOX STRAP
Attatch with shingle nails

Note: All lettering to be stenciled on box 1" high.



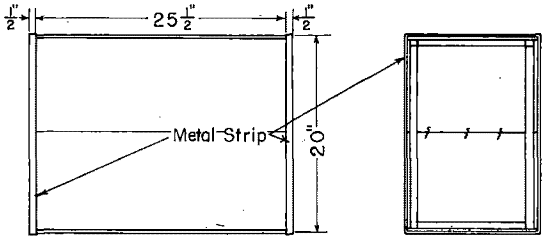
See "Outside Unfolded View" for lettering
Top, bottom and sides 3/8" box material
13 1/4"

TOP VIEW



12 1/2"
9 3/8"
9 3/8"
18 3/4"

CENTER PARTITION
2 Pieces, 3/8" box material

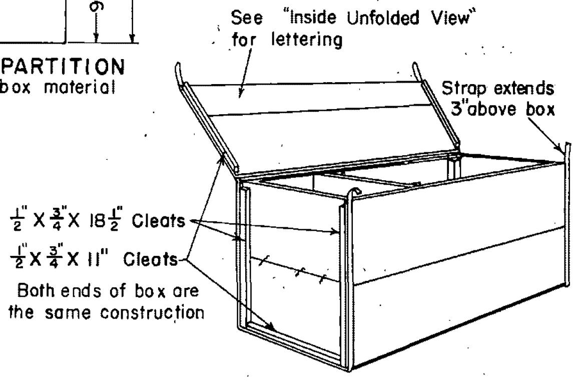


1/2"
25 1/2"
1/2"
Metal Strip
20"

SIDE VIEW

END VIEW

ASSEMBLED BOX



See "Inside Unfolded View" for lettering
Strap extends 3" above box
1/2" X 3/4" X 18 1/2" Cleats
1/2" X 3/4" X 11" Cleats
Both ends of box are the same construction

PERSPECTIVE VIEW OF BOX

COMBINATION RATION BOX & TABLE TOP

L.G.G. – U.S.F.S., W.O., 1947

SECTION O

SUBSISTENCE SUPPLIES

Subsisting Fire-Protection Forces

Along with the need for nested mess outfits, special fire-fighting tools, etc., there is the need for special ration lists, rations, and facilities for quickly and adequately subsisting the men who combat forest fires. The more difficult the transportation problem, the greater the need. An inadequately subsisted fire crew or a delay in the kitchen serving line can very easily, and frequently does, result in the loss of a hundred man-hours of work on the fire line, often during the time of day best suited to fighting fire.

The ensuing data give an insight into some of the various methods employed in subsisting fire crews and fire-protection forces. References are provided for those who wish to obtain further detailed information regarding those subjects which cannot be fully presented here.

Ration, One-Day, Army E.—Ration E is now issued by the Army for field troops to replace Rations K and C, which were used extensively by the Forest Service during and after the war to feed smokechasers and fire fighters. The E ration weighs 5 pounds 3½ ounces and contains 3800 calories. Six rations are packed in a carton, shipping weight about 40 pounds.

Each ration is composed of 7 cans, one accessory packet, and one packet of cigarettes and matches. The cans contain 3 meat units, 2 biscuit units (B-1 and B-2), one bread unit, and one fruit unit.

The B-1 unit is for breakfast and contains cocoa, coffee, sugar, crackers, jam, and cereal. The B-2 unit is for supper and contains coffee, fruit juice powder, candy, crackers, cookies, jam, and sugar. The bread unit contains 4 ounces of canned white bread.

As packed for the Army, the fruit and meat units are assorted varieties. Four different fruits are provided: peaches, pineapple, apricots, and fruit cocktail. Meat units, 12 ounces each, consist of 10 varieties: chicken and vegetables, hamburgers and gravy, pork and rice, pork and beans, ham and lima beans, beef stew, meat and beans, frankfurters and beans, meat and noodles, and ground meat and spaghetti.

The accessory package contains chewing gum, granulated salt, heat tablets, water purification tablets, toilet paper, spoons, and can opener.

Experimentation and development of the E ration is continuing, therefore rations purchased in future may vary somewhat from the above description.

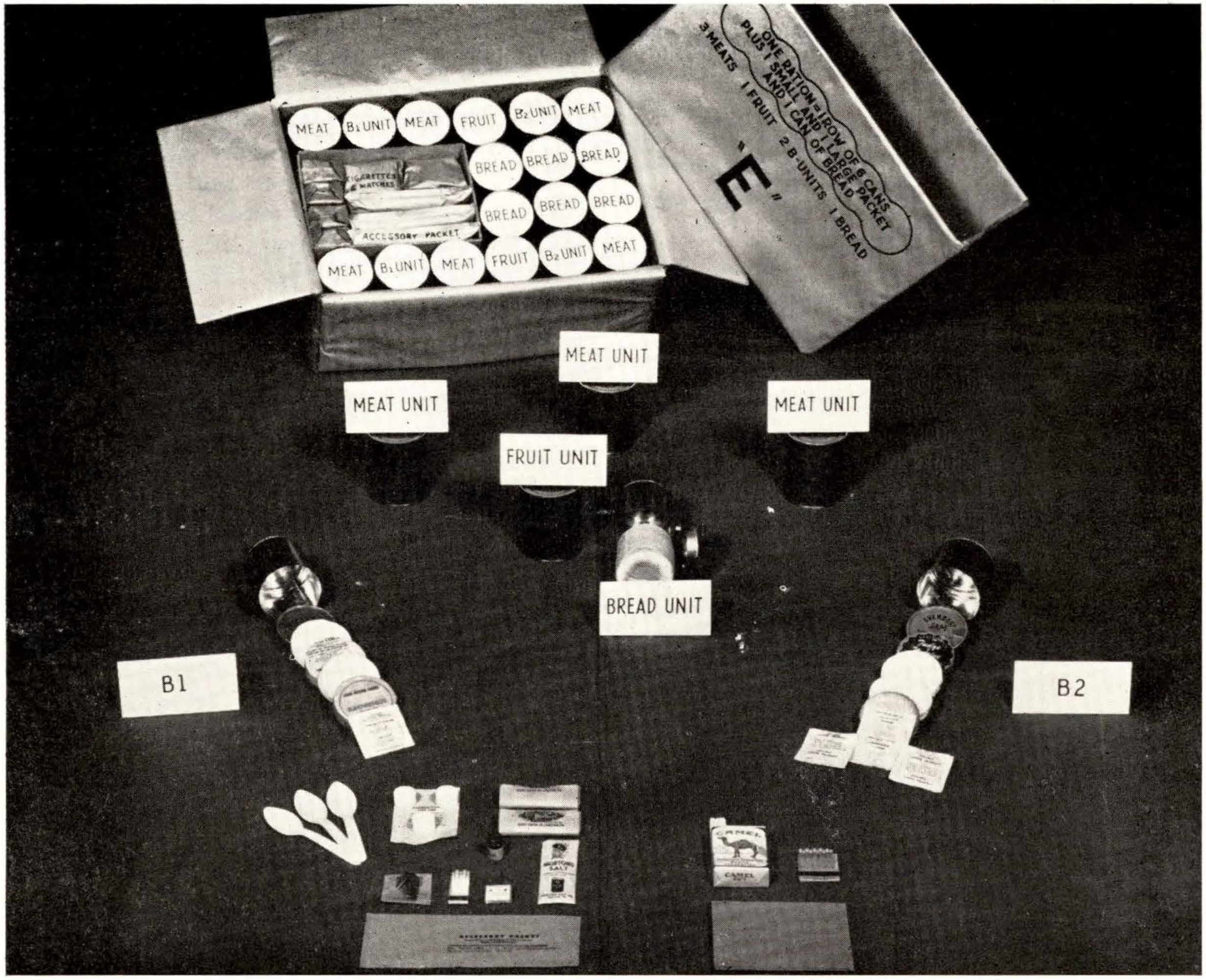

MEAT
B1 UNIT
MEAT
FRUIT
B2 UNIT
MEAT
CIGARETTES & MATCHES
BREAD
BREAD
BREAD
BREAD
BREAD
BREAD
ACCESSORY PACKET
MEAT
B1 UNIT
MEAT
FRUIT
B2 UNIT
MEAT
ONE RATION = 1 ROW OF 6 CANS
PLUS 1 SMALL AND 1 LARGE PACKET
AND 1 CAN OF BREAD
3 MEATS 1 FRUIT 2 B-UNITS 1 BREAD
"E"
MEAT UNIT
MEAT UNIT
MEAT UNIT
FRUIT UNIT
BREAD UNIT
B1
B2
CAMEL

FIGURE O-1—Army Ration E

RATION LIST AND TABLES

The following fire-crew ration list and ration tables work out quite efficiently when used as guides in preparing or ordering subsistence supplies for fire crews. The fire crew ration list is compiled on the basis of 10-man units, unit 1 being for 10 men, unit 2 for 20 men, etc., for 1 day. The ration tables are compiled on the basis of one man for 1 day:

Fire-crew ration list for 10 to 50 men

(To be used by camp bosses ordering and merchants furnishing food supplies)

Article	Unit	Quantity [1] for—				
		1 unit	2 units	3 units	4 units	5 units
Fresh meat	Pound	10	20	30	40	50
Ham	do	4	8	12	16	20
Bacon	do	2	4	6	8	10
Bread	Loaf, large	9	18	27	36	45
Shortening compound	Can	1	2	3	4	5
Sugar	Pound	4	8	12	16	20
Eggs	Dozen	3	6	9	12	15
Coffee, ground	Pound	2	4	6	8	10
Milk, canned	Large size	4	8	12	16	20
Butter	Pound	1½	3	4½	6	7½
Prunes, dried	do	2	2	3	3	3
Peaches	Quart can	2	4	6	8	10
Apricots	do	1	2	3	4	5
Rice	Pound	2	4	6	8	10
Beans, pink	do	3	6	9	12	15
Potatoes	do	10	20	30	40	50
Onions	do	1	2	3	4	5
Tomatoes, solid pack	Quart can	3	6	9	12	15
Macaroni	Pound	1	2	3	4	5
Cheese	do	2	4	6	8	10
Minced ham	do	2	4	6	8	10
Pickles	Quart	1	2	3	4	5
Salt	Pound	1	1	1	2	2
Pepper	Ounce	2	2	4	4	4
Dish towels	Number	3	3	5	5	5
Hand towels	do	3	3	4	4	4
Ivory soap	Bars	2	3	4	4	4
Matches, boxed	Boxes, large	1	2	3	4	5
Paper bags, size No. 8	Number	12	24	36	48	60
Jam, assorted, in cans	Quart	2	4	6	8	10
Tomato Juice	15-ounce can					[2]48

[1] 10 men, 1 day=1 unit; 20 men, 1 day=2 units; 30 men, 1 day=3 units; 40 men, 1 day=4 units; 50 men, 1 day=5 units; 20 men, 2 days=4 units.

[2] Cans.

After first order, officer in charge of camp should, of course, order food supplies as needed, using the table as a guide, substituting vegetables where and when possible to offset heavy foods.

Combination ration table—1 man for 1 day

Balanced ration for 1 man for 1 day [1]	Amount [2]	Equivalent substitutes for staple items in column 1
Fresh meat	1.50 pounds.	Bacon 0.7 pound, ham 0.9 pound, canned meat 1.2 pounds, eggs 12, beans 1 pound.
Cheese	0.06 pound	Sweet chocolate 0.06 pound, fresh meat 0.12 pound.
Beans	0.2 pound	Rice, hominy, or lentils 0.2 pound, baked beans 1/3 can or 0.5 pound.
Bread	1 pound	Flour 0.8 pound, crackers 0.7 pound, corn meal 0.8 pound, macaroni 0.7 pound.
Baking powder	0.04 pound	Yeast (for light bread) 1/5 cake, soda (for sour dough) 0.01 ounce.
Oatmeal	0.15 pound	Cream of wheat, corn meal, rice, corn flakes 0.17 pound.
Potatoes	1 pound	Rice, hominy, or beans 0.25 pound, evaporated potatoes 0.15 pound.
Fresh vegetables	0.35 pound	Peas, corn 1/5 can or 0.25 pound, tomatoes ½ can or 0.9 pound, dried vegetables 0.7 pound.
Dried fruit	0.1 pound	Canned fruit ¼ can or 0.45 pound, fresh fruit 0.5 pound, raisins 0.10 pound.
Canned fruit	¼ can	Jam or apple butter ⅛ can; dried fruit 0.10 pound.
Coffee	0.13 pound	Tea 0.03 pound, cocoa 0.08 pound
Sugar	0.4 pound	
Milk (evaporated)	1/3 can	Fresh milk 2/3 pint, powdered milk 2/3 ounce.
Butter	0.12 pound	Peanut butter 0.12 pound.
Lard	0.1 pound	Bacon grease 0.10 pound.
Salt	0.04 pound	
Pepper	0.06 ounce	Red pepper 0.0015 pound.
Sirup*	1/12 pint	
Pickles*	1/15 pint	Vinegar, 1/25 pint.
Cinnamon*	0.04 ounce	Ginger, nutmeg, cloves, mustard, or allspice 1/25 ounce.
Extracts*	0.03 ounce	
Cornstarch*	0.02 pound	Tapioca, 0.02 pound.
Matches		
Soap		
Total weight	6 pounds	Lighter ration obtained by selecting the lighter substitutes.

[1] Items marked with an asterisk (*) are essential only in permanent or moderately large camps.

[2] All weights given are exclusive of cans or other containers.

Simple ration table—1 man for 1 day

Supplies [1]	1-day ration	Supplies	1-day ration
Fresh meat, including fish (a).	1 pound.	Canned fruit (g).	0.25 can
Cured meat or canned meat (b)	0.40 pound.	Sugar	0.40 pound
Cheese	0.08 pound.	Coffee (h)	0.12 pound
Bread, flour or crackers (c).	0.80 pound.	Milk, evaporated (i).	0.30 can
Baking powder or yeast cakes.	0.04 pound.	Butter (j)	0.10 pound
Cereals or corn meal.	0.15 pound.	Lard (k)	0.10 pound
Potatoes or other fresh vegetables (d).	1.20 pounds.	Salt	0.04 pound
Rice or beans	0.20 pound.	Pepper	0.08 ounce
Canned vegetables (e).	0.15 can.	Sirup*	0.01 gallon
Dried fruit (f)	0.10 pound.	Spices*	0.04 ounce
		Flavoring ext.*	0.04 ounce
		Pickles	0.03 quart
		Vinegar*	0.01 quart
		Soap & matches	
		Total weight	6 pounds

[1] Items marked with an asterisk (*) are essential only in large or permanent camps.

Note: Page number O-4 is missing.

SECTION P

MEDICAL AND SAFETY EQUIPMENT

Kit, First-Aid, 1- to 10-Man.—This kit (fig. P-1) is designed for individual emergency use and so packaged as to stand rough handling. It is prepared particularly for use in cases of burns or cuts, or fainting spells. It is pocket size, with metal container, 4½ by 2½ by 1½ inches.

Contents

6 1-inch adhesive compresses.
10 Yards 1-inch gauze bandage.
2 Tubes ⅛-ounce carbolated petrolatum ointment.
1 Ammonia inhalant.
1 2-inch bandage compress.
1 Adhesive tape 1½-inch x 5 yards.
4 Iodine swabs.

Container may be purchased in accordance with Federal Specification No. GG-K-391, except as to dimensions, Type I, Grade A or B as specified. Items listed in contents may be purchased under the same specification where applicable.

Approximate cost, 95 cents; replacement items, 10 to 36 cents each.

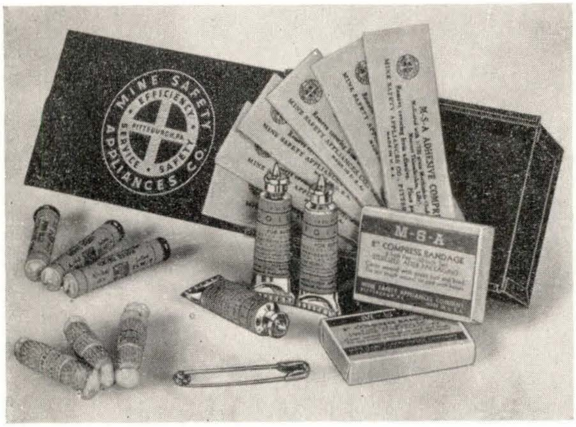


FIGURE P-1.—One-man medical kit.

Kit, First-Aid, 10- to 25-Man.—This kit (fig. P-2) is known as a 10-unit all-weather type. A flat molded rubber gasket excludes dust, dirt, or moisture. Supplies are included for burns, cuts, fainting spells, and bone fractures. The container is metal, 8 by 5½ by 2½ inches.

Contents

1 Unit package (16) adhesive compresses.
2 Unit package (4) 2-inch compress bandages.
1 Unit package 4-inch compress bandages.
1 Unit package 40-inch triangular bandages.
1 Unit package (6 tubes) ⅛-ounce carbolated petrolatum.
1 Unit package (10) iodine brushes.
1 Unit package tourniquet and forceps.
1 Unit package wire splint.
1 Unit package (10) ammonia inhalants.

Container may be purchased under Federal Specification No. GG-K-391, Type II, Grade B, Class B.

Items listed in contents may be purchased under the same specification where applicable.

Approximate cost, $3.55; replacement items cost as in one-man kit.

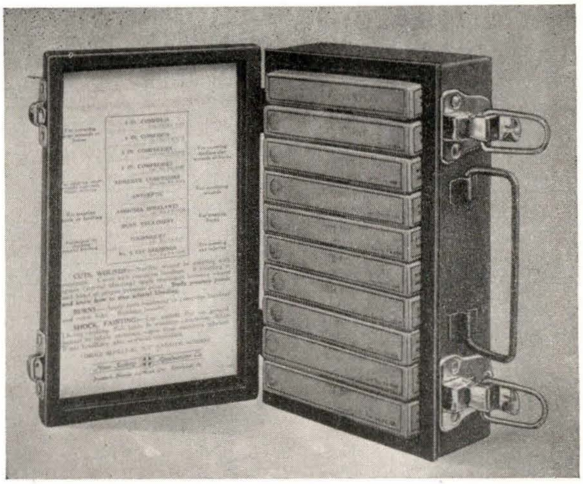


FIGURE P-2.—Ten- to twenty-five-man medical kit.

Kit, First-Aid, 25- to 50-Man.—This is the 36-unit type, weatherproof with gasket, and furnished with wall brackets for mounting, if desired. It includes supplies for burns, cuts, fainting spells, bone fractures, eye injuries, poison-oak infections, cathartic remedy, toothache, and headache medicines. The container is 24-gage steel, 13⅛ inches by 10 inches by 2½ inches. Unit packages are similar to those shown in figure P-2.

Contents

4 Unit package (64) 1-inch adhesive compresses.
2 Unit package (8) 2-inch compress bandages.
2 Unit package (2) 4-inch compress bandages.
1 Unit package absorbent gauze compress.
2 Unit package (2) 40-inch triangular bandages.
1 Unit package wire splint
1 2-unit pack absorbent cotton.
1 Unit package eye dressing unit.
2 Unit package (20) iodine brushes.
1 Unit package (10) ammonia inhalant.
1 3-ounce tube cream (for poison oak).
2 Packages 1 inch by 2½ yards adhesive tape (2 per package).
1 Package 10 gram oil of cloves (toothache remedy).
2 Bottles aspirin tablets (36 per bottle).
1 Bottle (50 cathartic pills).
1 Unit package sterile applicators (4) and wooden stick applicators (12).
1 1-ounce tube carbolic acid ointment.
1 4-inch scissors.
1 2-unit package snake bite outfit.
1 Package muslin finger cuts (4 per package).
1 Package sulphadiazine tablets (24 per package).
1 Empty 2-ounce bottle for alcohol.
1 Instruction book.

Container may be purchased under Federal Specification No. GG-K-391, Type II, Grade B, Class B. Items listed in contents may be purchased under the same specification where applicable.

Approximate cost, $11.25. Replacement items cost as in one man kit.

Kit, Snake-Bite.—This kit (fig. P-3) includes the essentials needed for the treatment of snake bites. The container is metal, 4 by 2½ by 1 inches.

Contents

- 1 Glass suction syringe.
- 1 Rubber adapter for bites between fingers and toes.
- 1 Lancet.
- 1 Iodine brush.
- 1 Army tourniquet.
- 1 Ammonia inhalant.
- 1 Lubricating jelly 1/16-ounce tube.
- 1 Paper cup.

Container may be purchased under Federal Specification No. GG-K-391, Type I, Grade A or 3, as specified. Items listed in contents may be purchased under the same specification where applicable.

Approximate cost, $2.

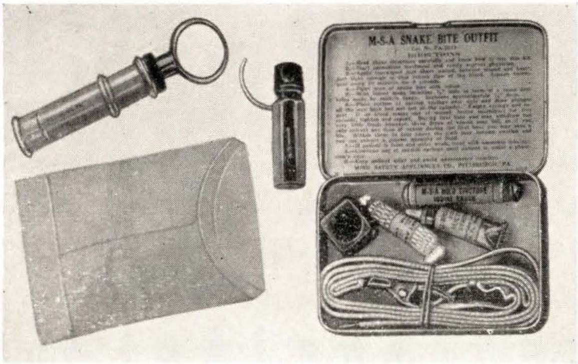


FIGURE P-3.—Snake bite first-aid kit.

Hat, Protective.—This is a rigid hat such as is used to prevent head injuries to steel workers, miners, and others similarly occupied. Its use in connection with fire control is mainly to protect workers from falling embers, limbs, and bark. The most suitable type is made of fibrous material, with adjustable sweatband. Approximate cost, $2.

Kit, Medicine, Veterinary.—This kit is recommended for use with plow teams on fire duty and also with any horse or mule units in the field. The medicine included is for the treatment of such common ailments as colic, blackwater, saddle and collar galls, calked feet, bruises, and wounds. The farrier's equipment is for replacing pulled shoes in the field.

The kit is contained in a wooden box, with a hinged lid and hasp, of a size and shape to hold the following items:

- 1 Pint pine tar.
- 1 8-ounce bottle creolin.
- 1 8-ounce bottle spirits of niter.
- 1 Can healing powder.
- ½-Pint colic remedy.
- 2 8-ounce bottles carron oil.
- 1 Farrier's hammer.
- 1 Pair farrier's nippers.
- 1 Farrier's knife.
- 1 Farrier's rasp.
- 1 Pound horseshoe nails.
- 1 Horseshoe, hind.
- 1 Horseshoe, front.

Shoe and nail sizes will be governed by sizes of horses to which kit is assigned.

The box illustrated (fig. P-4) is 17 inches long, 8½ inches wide, and 8½ inches deep, inside dimensions. Approximate cost, $8.

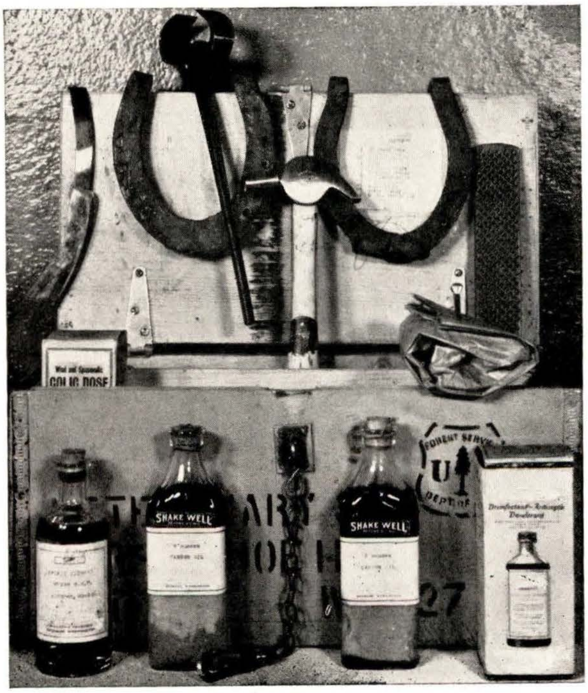


FIGURE P-4.—Veterinary medicine kit.

SECTION Q

SHARPENING EQUIPMENT

Files.—Mill bastard flat files are used for sharpening axes, hoes, and other fire tools, except saws. For saws, a special crosscut saw file is used. First-grade files should be procured for these uses.

Stone, Ax, Hand.—A fast-cutting, vitrified abrasive pocket stone, 3 inches in diameter and ⅝-inch thick, for honing the edges of axes and other cutting tools after grinding or filing. One side of stone is of coarse grit and the other side of fine grit. Approximate cost, 50 cents.

Outfit, Saw-filing.—The Forest Service standard specification provides for raker gage, cutter tooth setting gage, swaging hammer, and set block. The raker gage has a malleable-iron frame, straight edge faced with tempered tool steel, and chilled plate for filing down rakers. The tooth gage is standard pattern, malleable iron, spider type. The hammer is 8-ounce, cross peen, with 12-inch handle.

A light canvas bag approximately 6 by 14 inches, with drawstring, is suggested as a container:

Figure Q–1 shows:

1. Cutter tooth setting gage.
2. Raker gage.
3. Morin lever set—cost about $4.50.
4. Saw-setting block.
5. Files.
6. Swaging hammer .
7. Outfit container.

Total cost, about $6.50.

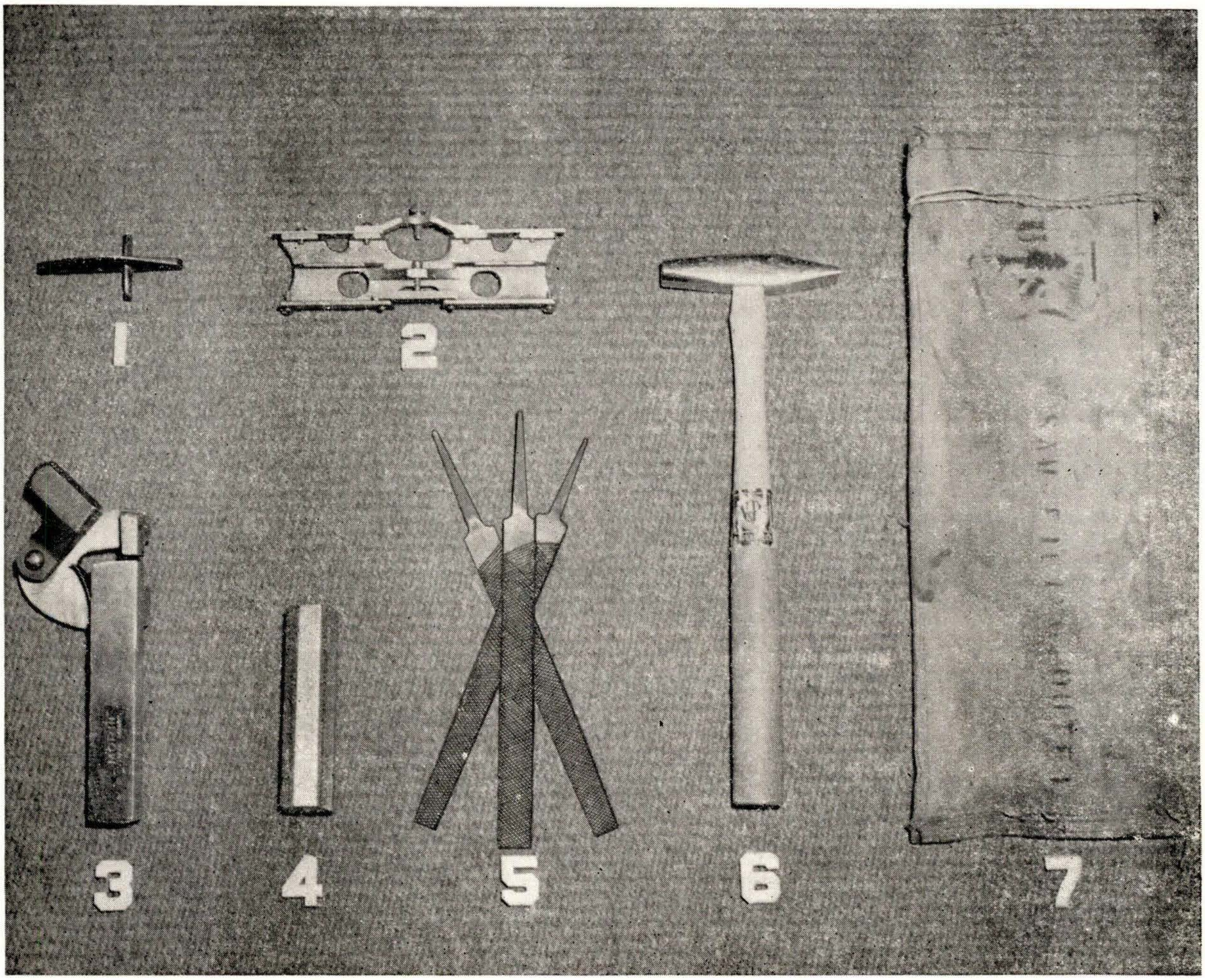


FIGURE Q–1.— Saw-filing outfit.

Grinder, Bench, Hand Power. — The Forest Service specification covers grinders suited to the requirements of the various grinding likely to be met and provides a thoroughly dependable tool in each of the following types:

A. Heavy-duty, ball bearing: Grinding wheel 8 by 1½ inches. Two single-row, multiple-ball bearings on grinding wheel shaft. Cast-iron gear case. Weight, 25 pounds.

B. Heavy-duty, plain bearing: Grinding wheel 7 by 1¼ inches. Cast-iron gear case. Weight, 20 pounds. Approximate cost, $12.

C. Medium-duty, plain bearing: Grinding wheel 6 by 1 inch. Weight, 12 pounds with cast-iron gear case, 8 pounds with aluminum-alloy gear case. (Case optional with manufacturer). Approximate cost, $8.

Gear cases on types A and B are so designed that all bearings are contained in the same casting to insure proper bearing and gear alinement. All types are equipped with tool rests. The specification calls for grinding wheels of medium grit and hardness, but can be changed to meet purchasers' requirements.

Grinder, Portable Power.—Designed for use at fire camps and at stations where electric power is not available (figs. Q–2, Q–3). Consists of a 1-hp. air-cooled gasoline engine mounted on a skeleton frame, a collapsible arbor frame, a grinder head, and a V-type link belt. The specification provides for two types of head. Type A carries two grinding wheels which turn in the same plane as the drive belt. On the type B head (fig. Q–3) the wheels turn in a plane 90° from the drive belt, and the head is mounted so that the wheel position may be changed from vertical to horizontal for face grinding. This type has three spindles, so that two operators may work at the same time, or the third spindle may be used for a wire brush or buffer. The Forest Service specification calls for three grinding wheels, 1½- by 10-inches, No. 36–W–M, but wheels of different grit and hardness may be purchased if required.

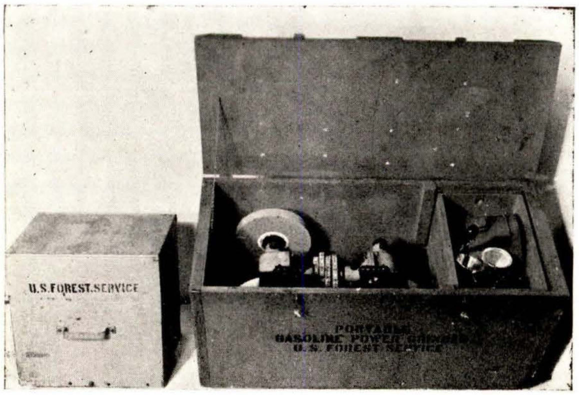


FIGURE Q–2.— Portable power grinder. Engine contained in carrier-type cover shown at left.

Weight of complete outfit, including shipping box, is approximately 225 pounds, but it can readily be disassembled for animal packing, the heaviest piece weighing about 80 pounds. Approximate cost, $150.

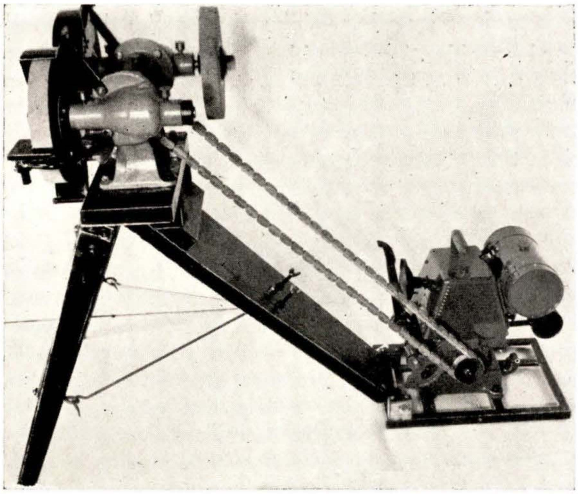


FIGURE Q–3.— Portable power grinder.

Dresser, Grinding-Wheel.—It is necessary to dress grinding wheels frequently to maintain true roundness and evenness of face. Unevenness in a wheel makes proper tool grinding impossible and causes an eccentric motion in the grinder head which results in excessive vibration and wear. Such vibration in a power grinder is dangerous; heavy grinding with an eccentric wheel may shatter the wheel. It is often necessary to dress new wheels before using them.

The most common and inexpensive grinding-wheel dresser consists of a japanned-iron handle and holder, in which are set three tooth-faced tool-steel disks, with a guide to hold the dresser square with the face of the grinding wheel. The rotation of the toothed disk against the face of the wheel removes uneven spots and dresses the face true with the holder. Replacement disks for the dresser may be obtained at low cost. Approximate cost, $1.

SECTION R

SMOKE-CHASER AND FIRE-CREW OUTFITS

Fire-Tool Outfits

There are many sizes and kinds of fire-suppression tool outfits used, which are made up of many different types and combinations of tools and equipment. To list them all is impracticable, therefore only a few of the more widely used outfits are described.

Outfit, Smoke-Chaser.—The one-man fireman or smoke-chaser outfit used quite extensively in the northwestern regions consists of the following items. These can be modified to meet local conditions and the kind of transportation available. (Fig. R–1.)

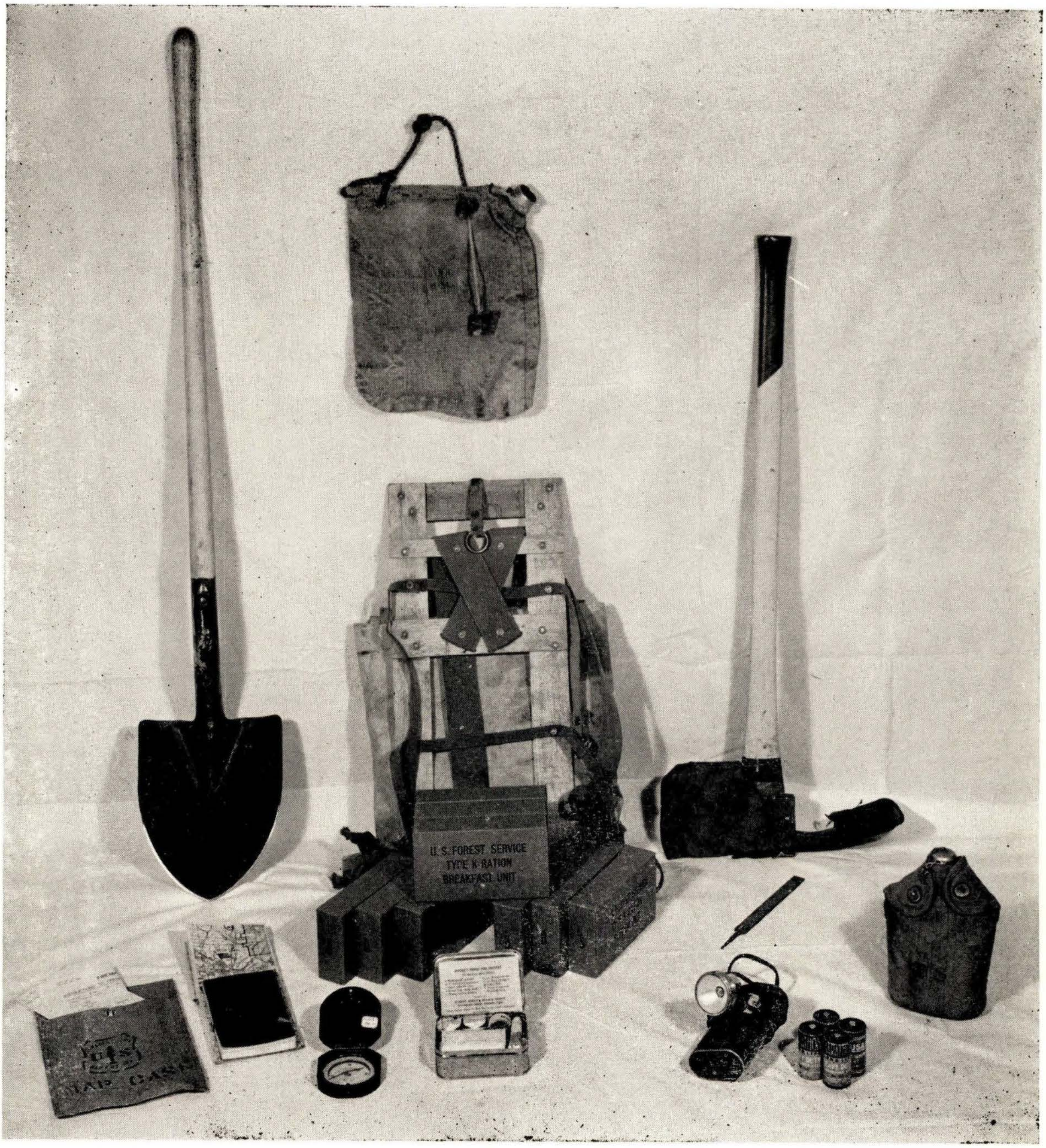


FIGURE R–1.—Fireman or smoke-chaser outfit. Shows Clack instead of canvas-lined pack board.

1 Canvas-lined pack board and bag.
1 Smoke-chaser map case containing 1 box pocket compass, 1 map (usually of ranger district), and pencil and report forms.
1 Pulaski tool and sheath.
1 Shovel, No. 0 or detachable handle, long-handle, round-point.
1 Electric headlight with extra bulb and batteries.
1 File, 8-inch, flat mill bastard.
1 Canteen (size according to local need).
1 Water bag, 2-gallon.
1 Individual first-aid packet.
1 One-day emergency ration (some localities two rations).

Some of the substitutions made to accommodate local requirements or transportation facilities are:

1. Clack pack board with light cargo canvas or a knapsack for the canvas-lined pack board.

2. Ax and hazel hoe for Pulaski tool.

3. Miners' carbide lamp with extra can of carbide or palouser with extra candles, for the electric headlight with extra bulb and batteries.

4. Ax stone for file.

5. Water bag for canteen.

6. Folding canvas bucket for water bag. The extra bag or bucket is sometimes left out entirely in localities where water is scarce as its main purpose is for carrying water to drown fire.

7. A hand pump and man-pack water bag or rubber-insert water bag are sometimes included as standard items.

8. A 4½-foot crosscut saw with handle and hardwood wedge are sometimes included as standard items .

The average standard fireman's pack weighs from 20 to 30 pounds, depending upon extra items carried and whether one or two rations are included.

Outfit, Tool, Back-Pack, 1- to 15-Man.—Region 1 uses a combination 1- to 15-man back-pack tool outfit (fig. R–2). This method is used to insure both adequacy and balance of tools, regardless of crew size, up to 15. It is designed to equip flying-squadron and other specially trained and organized crews and is particularly adaptable in localities where travel is mainly on foot. Three outfits make up a very effective 50-man back-pack crew tool unit.

The outfit contains a sufficient number of lights to permit night travel and work. It also includes a sufficient number of one-man rations to feed the crew for about a day and a half.

Each pack is cargoed in lightweight canvas and strapped to a Clack pack board. The packs average about 19 pounds apiece, including pack board.

Contents of the 1- to 5-man units are listed below. In some localities extra tools, such as shovels and Pulaskis, are kept with each 15-man outfit ready for last-minute substitution for the saws in packs 8 and 13 if it is felt one saw will be sufficient for the crew.

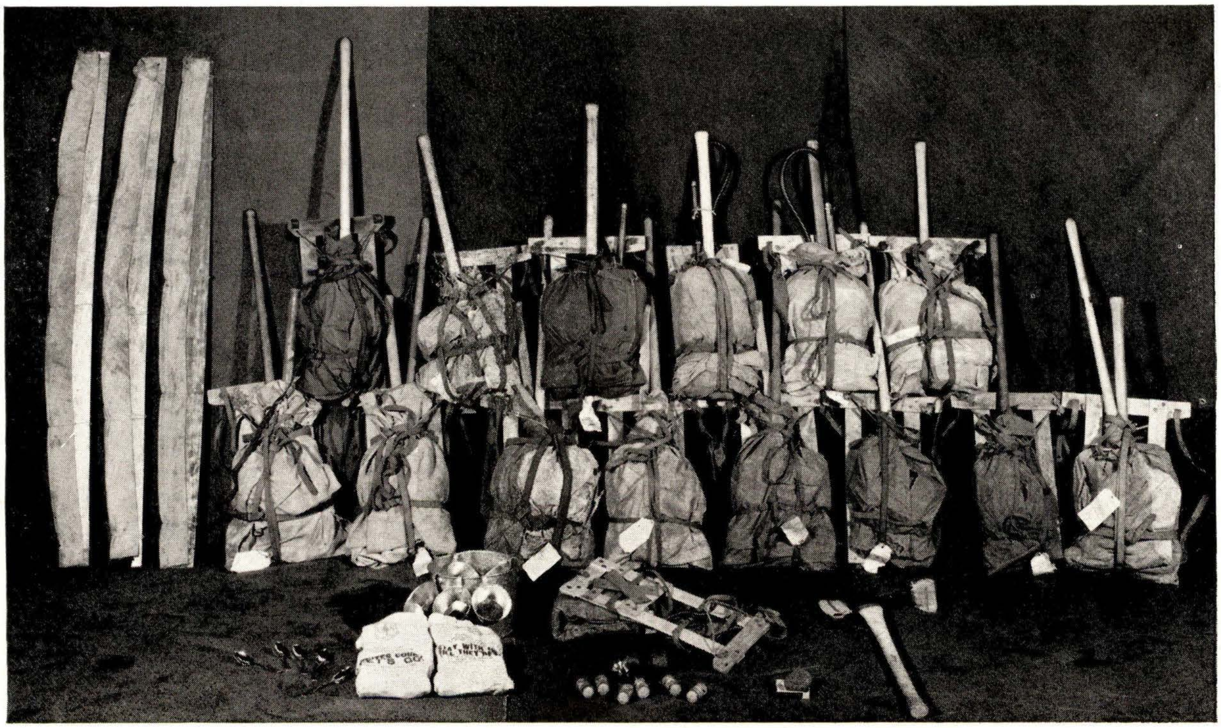


FIGURE R–2.—Region 1 one- to fifteen-man back-pack outfit.

Contents of 1- to 5-Man Outfit:

Pack No. 1

1 Compass and map.
1 Bag, water, 2-gallon.
6 Batteries No. 950.
1 File, 8-inch.
1 Headlight.
1 Frame, pack, Clack.
1 Pack cover.
1 Ration, 1-day.
1 Shovel, No. 0.
1 Tool, Pulaski.

Pack No. 2

1 Ax, double-bit 3½-pound.
1 Bag, 5-gallon, man-pack.
1 Canteen, 1-quart .
1 Frame, pack, Clack.
1 Pack cover.
1 First-aid package.
1 Pump, hand, with hose.
1 Ration, 1-day.

Pack No. 3

1 Frame, pack, Clack.
1 Pack cover.
1 Ration, 1-day.
1 Saw, crosscut, 5½-foot.
2 Saw handles.
1 Shovel, No. 0.
1 Wedge, falling, 2½-pound.

Pack No. 4

6 Batteries No. 950.
1 Bucket, tin, 6-quart.
5 Cups, miners', tin.
1 File, 8-inch.
1 Headlight.
1 Frame, pack, Clack.
1 Pack cover.
2 Rations, 1-day.
5 Spoons, dessert.
1 Stone, ax.
1 Tool, Pulaski.

Pack No. 5

1 Cover, pack.
1 Frame, pack, Clack.
2 Rations, 1-day.
1 Shovel, No. 0.
1 Tool, Pulaski.

Outfit, Tool, 5-Man, R–2.—This is an arrangement of hand fire tools of sufficient quantity and kinds to equip five men adequately for any type of fire fighting (fig. R–3). The outfit is particularly adapted for use in connection with cooperators' tool caches and out-of-the-way locations where a small number of tools is likely to be needed for fire suppression. As used in Region 2 it consists of the following:

4 Shovels (No. 2 or No. 0).
1 Double-bit ax, 3½-pound.
1 Saw (either one or two-man).
1 File, 12-inch flat.
1 Pulaski tool.
2 1-quart canteens.
2 1-gallon canteens.
1 Canvas bucket.
1 Oil or gas lantern.
1 Gallon kerosene or gasoline in can.
1 First aid packet.
12 Time slips, Form 874-15a.
1 Pencil.
Burlap or gunny sack.

This tool cache completely assembled weighs about 50 pounds. The approximate cost of purchase is $23.

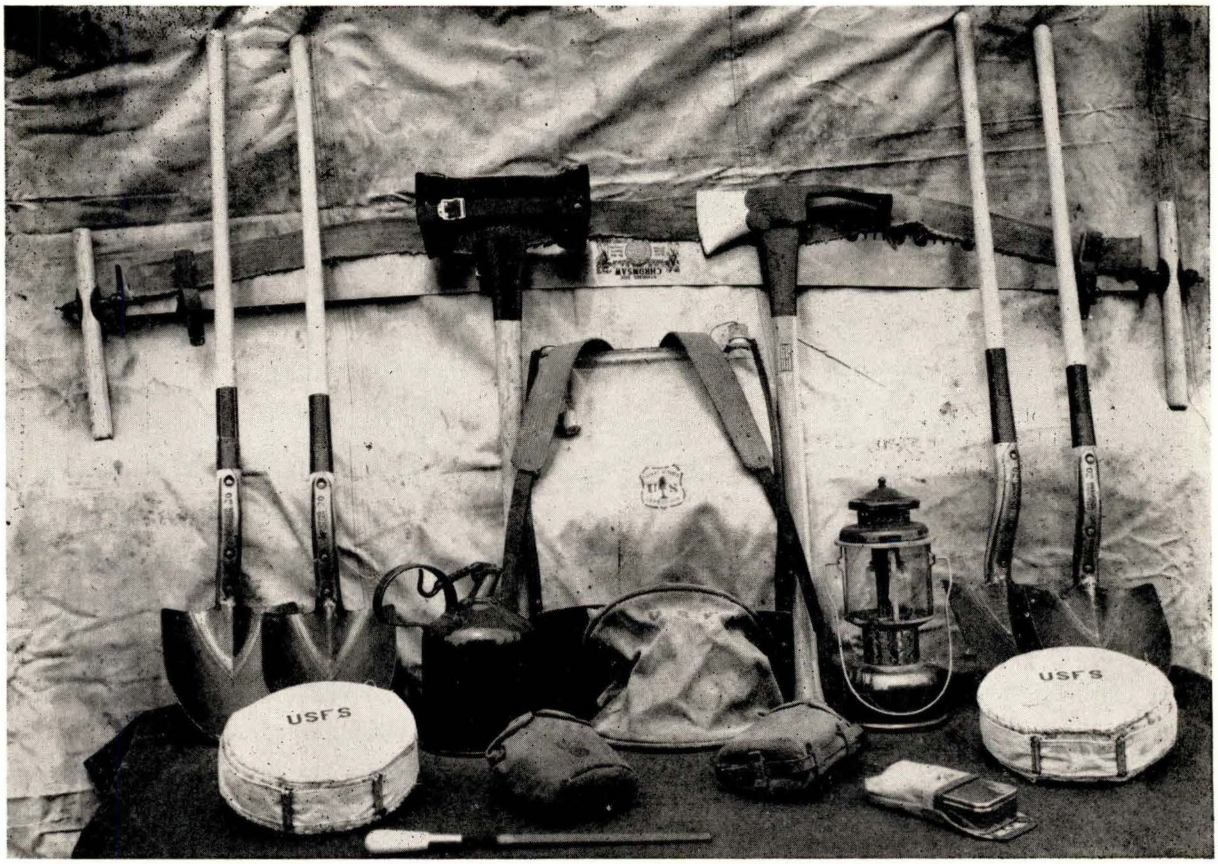


FIGURE R–3.— Five-man tool outfit.

Outfit, Tool, 12-Man, Appalachian.—A specially designed box carries the following tools:

Item	*Number*	*Weight*	
		Pounds	*Ounces*
Ax, d. b.	2	10	
Ax, s. b.	1	4	5
Brush hook, double edge	2	9	4
Bucket, canvas	2	3	14
Canteen, 1-gallon	4	9	
Kerosene, ½ gallon in can	1	4	
Grease in can	1	1	
Hoe, hazel	2	10	
Knapsack	1	5	12
Files	2		
Fusees	2		
Kit, first aid	1		
Kit, snake-bite	1		
Stone, ax	1		
Lanterns, filled	2	8	
Headlight, electric, (optional) with batteries	12	15	12
Pump, back-pack (empty)	2	26	
Rakes, fire (council tool)	10	35	10
Saw, cc w/handles	1	7	12
Shovel	1	4	5
Wedge	1	2	8
Total weight		157	2
Weight of box		155	

Cost: Box $20; tools $100. (See fig. R-4.)

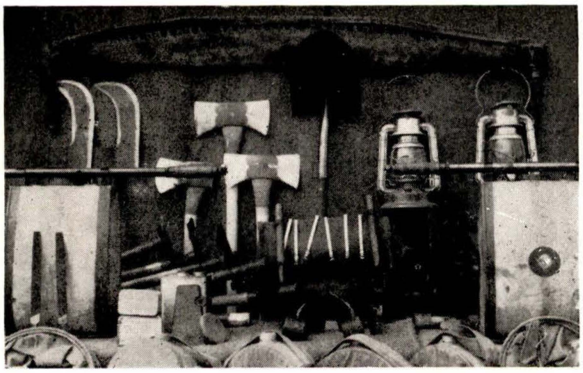


FIGURE R-4.— Appalachian 12-man tool outfit.

Outfits, Tool, 6-, 12-, and 25-Man.—Region 8 has standard lists for 6-man, 12-man, and 25-man outfits, as listed below. The 6-man outfit is shown in figure R-5. In the 25-man outfits, axes may be replaced with Pulaskis, and the mattocks or hazel hoes may be eliminated. In the 6- and 8-man outfits, the mattocks or hazel hoes may be replaced with Pulaskis. Additional Pulaskis may be added to any outfit if needed. Potato hooks, telephone, torch, wedge, and sledge are optional. The knapsack is optional in the 6-man outfit.

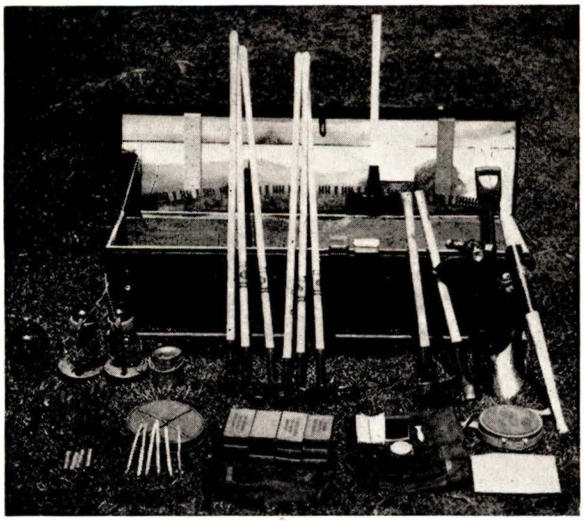


FIGURE R-5.— Six-man fire-tool outfit, R-8.

Item	*6-Man*	*12-Man*	*25-Man*
	No.	*No.*	*No.*
Axes	1	1	4
Blankets (bedrolls—3 blankets each)			50
Bucket (water-canvas)	2	4	6
Brush hooks	1	2	2-4
Camp boss outfit			1
Canteens (4-quart)	1	2	4
Cots (folding)			25
First aid kits (large, flat)			1
Fusees (20-minute type)	4	6	16
Gasoline ....Gallons—			2
Headlights, electric, (interchangeable with kerosene lanterns)	6	12	25
Headlights, carbide, (interchangeable with kerosene lanterns)	6	12	25
Hooks, potato	(1)	(1)	(1)
Carriers, timber	1	1-2	2-4
Kerosene (for lanterns) ....Gallons—			2
Kit (snake-bite)	1	1	1
Knapsack (for rations, etc.)	1	1	1
Knapsack, case or bag, containing:	1	1	1
Whetstone, carborundum	1	1	2
10″ file	1	1	2
First-aid kit (small)	1	1	2
Fire time slips (Form 15-A)	12	24	50
Notebook	1	2	3
Pencils	1	2	3
Headlights, electric	1-2	1-3	2-4
Lanterns, kerosene	2	4	8
Lanterns, gasoline			3
Map	1	1	1
Mattock or hazel hoe	1	2	2-4
Mess outfit (by size—6, 10, 15, 25, etc.)		1	1
Pump, back-pack, complete	1	2	4
Rakes (asphalt)	(1)	(1)	(1)
Rakes (council or rich fire tool)	6	12	24
Rations (Army "K" or equivalent)	12	24	48
Saws, crosscut w/handles	1	1-2	2-4
Scout outfit, each containing:			1
Knapsack or equivalent			1
Hand ax or equivalent			1
Box compass			1
Notebook—pencil			1
Map			1
2 ration "K"			2
2 fusees (20-minute)—matches			2
Seals	6	6	6
Shovels, L.H.R.P. No. 2 or No. 0	1-2	2-4	4-6
Stoves, Kimmel			1
Tables, roll top (6′ to 10′ each)			1
Tents and/or tarpaulins			1
Telephone, portable			1
Torch, backfire, propane			1
Wire, telephone emergency			2
Radio, portable			1
Reel, emergency wire takeup			1
Wedge	(1)	(1)	(1)
Sledge or single bitted ax	(1)	(1)	(1)

(1) Optional.

Outfit, Tool, 8-Man, R–6.—The equipment listed below is used in Region 6 as the basis for an eight-man standard tool outfit for a forest or ranger district. Substitutions are made to fit local conditions, e.g., McLeod tools for adz hoes, knapsack for pack board, steel wedges and sledges for wooden wedges. Where fuel types make it necessary to do so, other changes are made or the numbers of certain items are increased. A standard six-man mess outfit is used, with enough plates, cups, knives, forks, and spoons for eight men.

- 1 Ax, clearing and chopping.
- 2 Bags, 2-gallon, or canteens, 1-gallon.
- 1 Can, saw oil, 1 pint, filled.
- 1 Can, or bag, back-pack, with pump.
- 1 Case, map, canvas.
- 2 Files, 10-inch.
- 2 Form 929, fire report, with instructions.
- 1 Form, list of contents.
- ½ Gallon gasoline.
- 2 Headlights, electric, with extra batteries.
- 2 Hoes, adz.
- 2 Kits, first-aid, individual size.
- 1 Lantern, gasoline.
- 1 Map, forest or ranger district.
- 1 Notebook and pencil.
- 1 Outfit, cooking and mess.
- 1 Pack board.
- 1 Saw, felling, with two handles.
- 3 Shovels. No. 0.
- 12 Time slips, with carbon paper.
- 3 Tools, Pulaski.
- 2 Wedges, wooden.
- 1 Whetstone.

A suitable box for this outfit is shown in figure I–21.

Outfit, 25-Man, R–1.—Region 1 uses the following 25-man outfit (fig. R–6) as standard for fire control work throughout the Region. The outfit is designed to facilitate transportation either by truck or pack animal. Each package or box is so arranged that it can be made into a side pack for a pack animal just as it comes from the central warehouse or fire-tool cache.

The outfit includes sufficient tools, mess equipment, and bedding to serve a 30-man crew, including the camp and kitchen force. It is called a 25-man outfit because it is intended to equip 25 men for actual fire-line work in addition to the camp and kitchen force.

- 1 25-man, nested mess outfit. Approximate weight, 112 pounds. (Refer to Sec. N for contents.
- 1 Auxiliary mess-equipment box. Approximate weight, 60 pounds. (Refer to Sec. N, Camp equipment.)
- 1 Torch and miscellaneous tool box. Approximate weight, 140 pounds.
- 2 Bags, water, 5-gallon, man pack.
- 2 Canteens, 2-quart.
- 1 Grinder, carborundum, hand power.
- 12 Headlights, electric.
- 1 Kit, medicine.
- 1 Pliers.
- 4 Pumps, hand, with hose.
- 1 Torch. liquid gas.
- 1 Board, Clack pack.
- 1 Scale, spring, 50-pound (not required with new type torch).
- 1 Wrench, adjustable.
- 1 Tool box. Approximate weight, 140 pounds.
    - 9 Axes, 3½-pound, double-bit.
    - 16 Tools, Pulaski.
    - 1 Kit, timekeeper's or camp-boss.
- 1 Tool package No. 1. Approximate weight, 117 pounds.
    - 2 Axes, 3½-pound, double-bit.
    - 4 Hammers, 4-pound.
    - 1 Peavy.
    - 16 Shovels, No. 0.
- 1 Tool package No. 2. Approximate weight, 70 pounds.
    - 2 Bags, water, 5-gallon, man pack.
    - 4 Sacks, pack.
    - 1 Gage, raker.
    - 1 Hammer, swaging.
- 1 Crosscut saw package. Approximate weight, 25 pounds.
    - 4 Saws, crosscut 5½- or 6-foot length.
- 5 Bundles, kapok sleeping bags. Approximate weight, 75 pounds each.
  Each bundle contains 6 kapok bags.
- 1 Stove and fly package. Approximate weight, 100 pounds.
    - 1 Kimmel camp stove.
    - 1 Tent fly, 14 by 16 feet.
    - 1 Half-oven size bake or or drip pan.
    - 1 Oven-size bake or drip pan.

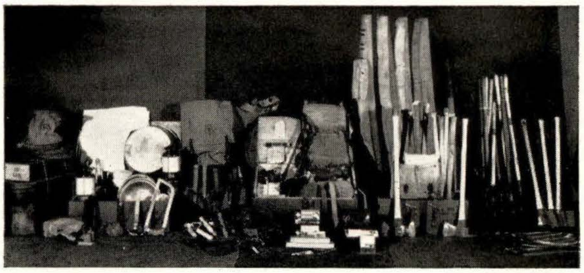


FIGURE R–6.— Region 1 twenty-five-man outfit. Kapok beds not shown.

Outfit, 25-Man, Supplemental, R–1. — Where crew or camp, Region 1 uses what is called a sup- more than 25 men are to be employed in any one plemental 25-man outfit (fig. R–7), which with their standard 25-man outfit provides tools and equipment for a 55- to 60-man crew, including camp and kitchen force. The supplemental outfit consists of the following packages or bundles including the items listed. Like the 25-man outfit this one is packed and ready for immediate transportation by truck or pack animal.

1 Supplemental mess outfit. Approximate weight, 86 pounds.

1 Supplemental torch box. Approximate weight, 136 pounds.

- 1 Torch, liquid gas.
- 1 Wrench, adjustable.
- 1 Scale, spring, 50-pound (not required with new type torch).
- 2 Sacks, pack.
- 4 Hammers, striking, 4-pound.

1 Supplemental tool package. Approximate weight, 140 pounds.

- 2 Axes, double-bit, 3½-pound.
- 16 Tools, Pulaski.
- 12 Shovels, No. 0.

1 Crosscut saw bundle. Approximate weight 25 pounds.

- 4 Crosscut saws, 5½- to 6-foot length.

4 Bundles kapok sleeping bags. Approximate weight, 75 pounds.

Each bundle contains six sleeping bags, except one, which has seven.

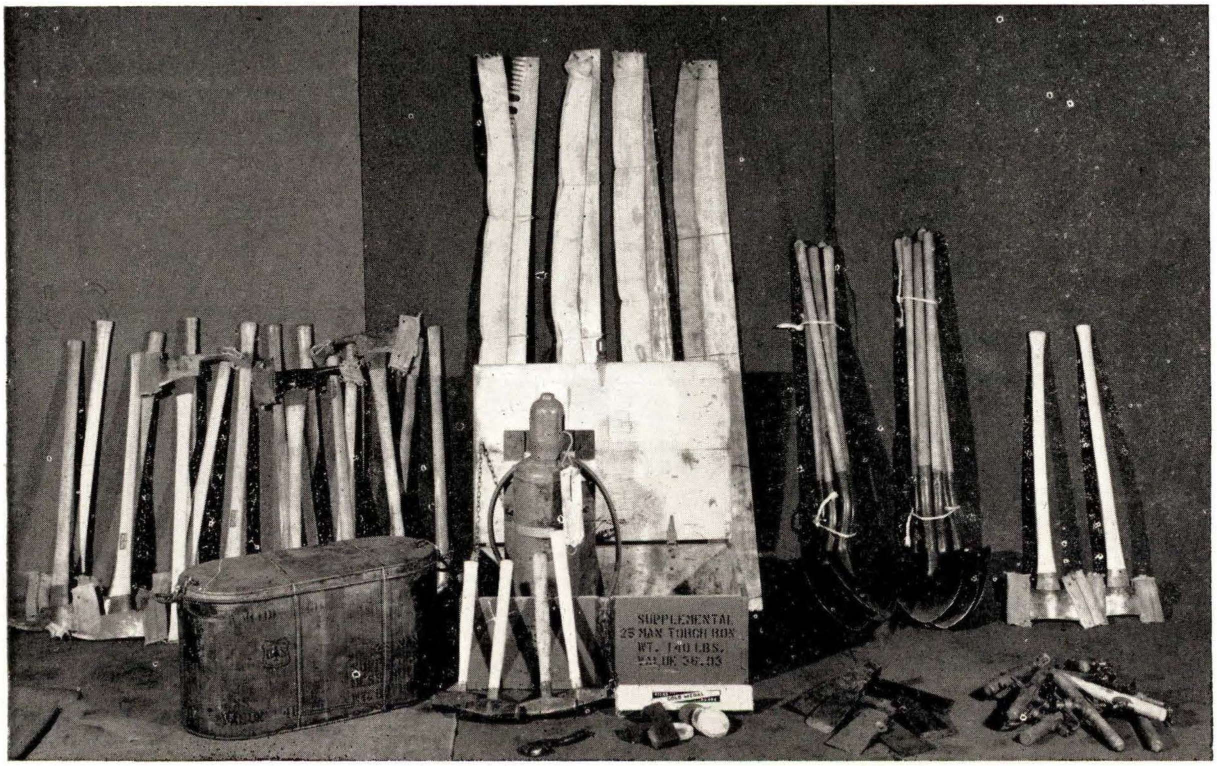


FIGURE R–7.— Region 1 twenty-five-man supplemental outfit, Kapok beds not shown.

Outfit, Tool, 50-Man, R–7.—This 50-man tool outfit (fig. R–8) is contained in seven boxes and is designed for truck transportation. Interior of boxes is designed to nest tools compactly and safely and protect the sharp edges. Lightweight hardwood is used for interior compartments. Each box is numbered, and a list of contents is stenciled on the exterior.

The 50-man unit provides for line construction in areas of slash, or where heavy cutting, clearing, and digging are required, as well as in areas where surface fires in hardwood types predominate. Under average conditions, several more than 50 men may be outfitted, if required.

Contents of boxes are as follows:

1.	1	Grinder, council tool
	1	Kit, first-aid.
	4	Water bags and pumps.
	6	Brush hooks.
	10	Fire rakes.
2.	10	Fire rakes.
	6	Brush hooks.
	4	Water bags and pumps.
	1	Kit, first-aid.
3.	2	Canthooks.
	6	Shovels, L.H.
	3	Saws 5½-foot w/handles.
4.	48	Fusees
	9	Hoes, hazel
5.	40	Carbide lamps
	40	Caps, miners'
	2	Gallons kerosene
	40	Flasks, carbide
	6	Lanterns, kerosene
	1	Funnel
6.	24	One-gallon canteens
7.	3	Sledge hammers
	9	Axes, d. b.
	12	Stones, carborundum
	12	Files, 8-inch
	3	Wedges

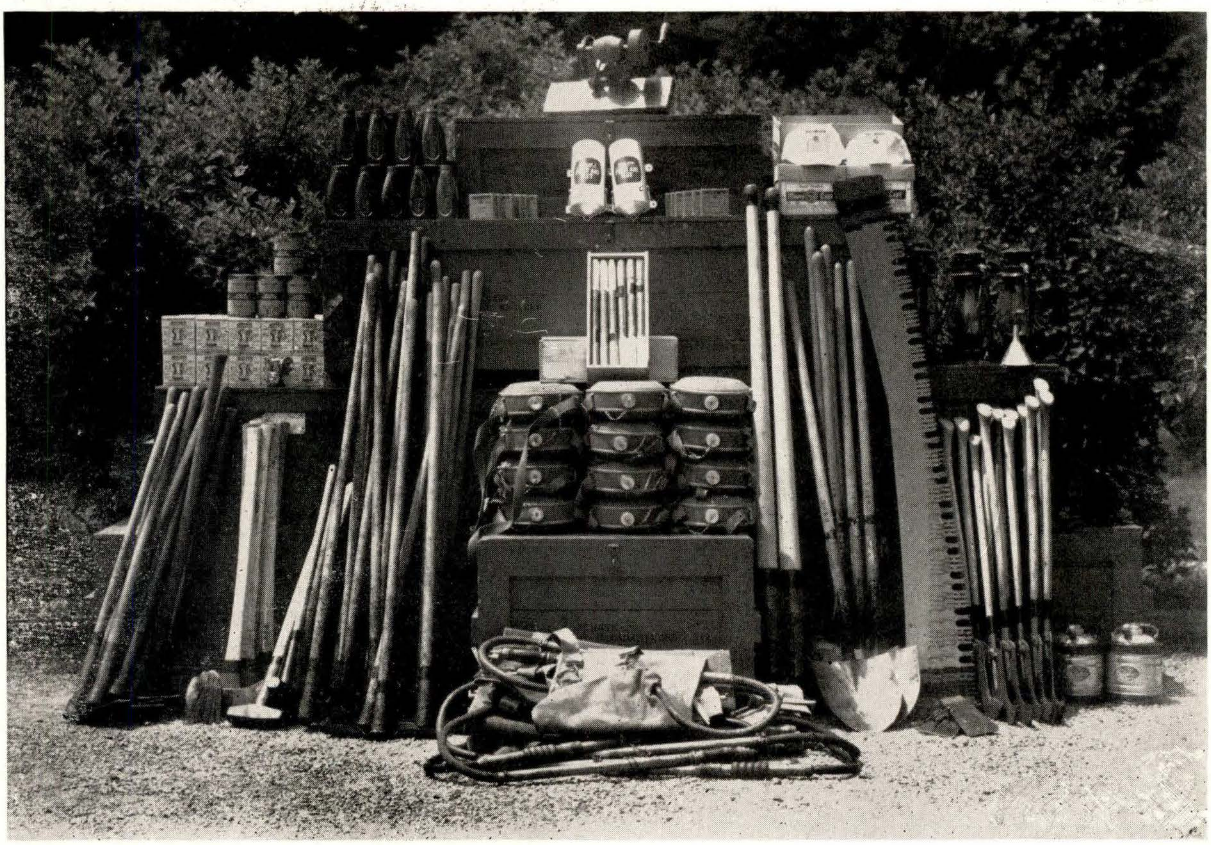


FIGURE R–8.— Fifty-man fire-tool outfit, R–7.

Outfit, Tool, 100-Man, R–6.—Region 6 uses a standard list of equipment for a crew of 100 men, as a basis for orders upon central caches and for assembling outfits at these caches. The list is printed on a regional form, which serves as a requisition and invoice. It has a "check" column and space for writing in items needed which are not included in the standard list. In placing orders, any standard items not needed for the particular job are deleted, and the numbers of certain items are increased or decreased as necessary to fit local conditions where the outfit is to be used. The standard list is as follows:

Line Equipment

5 Axes, cruising
18 Axes, clearing and chopping
14 Bags, water, 2-gallon
2 Bags, water, 5-gallon
12 Canteens, 1-gallon
12 Cans, back-pack, with pumps
12 Files, 10-inch
1 Case fusees
24 Headlights, with 2 sets of batteries
18 Hoes, adz.
24 Kits, first-aid, individual size
4 Outfits, felling
30 Shovels, No. 0
36 Tools, Pulaski
12 Whetstones

Felling Outfit

2 Axes, felling or swamping
1 Can, oil
1 File, 10-inch
1 Sack, burlap
200 Bags, lunch, cloth
12 Basins, wash
110 Beds
4 Buckets, canvas
12 Files, 7- or 8-inch
4 Files, canvas, 16x22 feet
1 Grinder, tool, hand, with oil
1 Hammer, claw
2 Irons, cooking
2 Kits, first-aid, medium
6 Knapsacks
8 Lanterns, gas, with extra mantles and generators, wrench, and funnel
4 Lanterns, oil, with extra oil
1 Saw, felling with handles
1 Sledge, 8-pound or 4-pound where steel wedges are used.
2 Wedges, steel or wood
1 Whetstone
4 Outfits, mess, 25-man, or 2 outfits, mess, 50-man
1 Outfit, camp-boss
1 Outfit, cobblers
1 Outfit, saw-filing
1 Pliers, slip-joint
1 Rake
1 Rasp, wood
3 Sacks, wool
1 Saw, bucking, with handles
1 Saw, hand
1 Screw driver, 8-inch
1 Sledge
2 Stoves, Kimmel, with special extra firebox
2 Wedges

Camp-Boss Outfit

1 Container, canvas roll, or box type, with list of contents
1 Book, alphabetical index
2 Crayons, lumber, blue
20 Envelopes, large, manila
20 Envelopes, small
2 Fire fighter's wage scale
10 Sets forms, compensation 1, 2, 16, and 17, with instructions
100 Forms, contract of hire
2 Forms, hourly wage table
100 Forms, purchase order
5 Sets forms, requisition and invoice, miscellaneous tools
50 Sets forms, subsistence inventory and requisition
250 Forms, time slip
1 Headlight, or flashlight, with extra batteries
1 Instructions, camp management, timekeeping, etc.
15 Notebooks, fire overhead, with 500 extra message forms
2 Notebooks, standard
1 Box paper clips
10 Sheets paper, carbon, large
10 Sheets paper, carbon, small
250 Sheets paper, ruled
6 Pencils, indelible
12 Pencils, No. 2
1 Box rubber bands
10 Signs, fire-camp
125 Tags, bed
25 Tags, linen
1 Box thumbtacks
24 Time books

The line and camp lists do not include such special equipment as torches, power pumps, tables, telephones, and radios, because the need varies and it is considered better to list such items on the requisition form with space to fill in the numbers required. Some of the forms and the instructions, overhead notebooks, and time books are regional rather than Forest Service standard items.

The 100-man outfit, except beds, is shown unpacked in figure R–9. Figure R–10 shows the same outfit packed for shipment from an interforest cache. The smaller boxes and crates are designed for convenient horse-packing and for dropping from an airplane. Axes, shovels, hoes, and Pulaski tools are bundled in burlap for the same purposes. However, the illustrations show one adz hoe crate and one ax box.

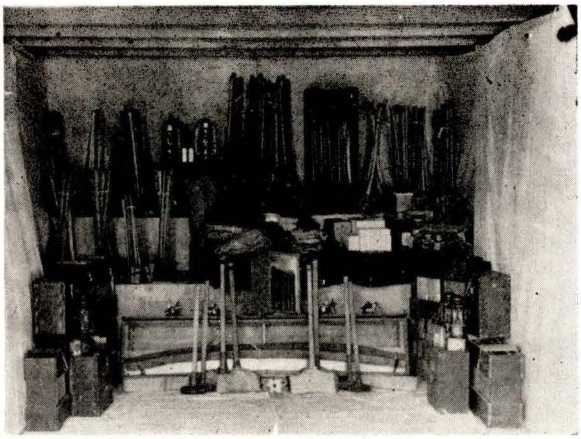


FIGURE R–9.— One-hundred-man outfit, except beds.

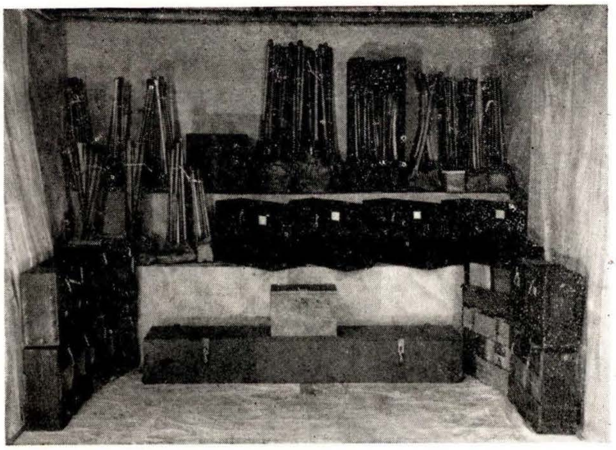


FIGURE R–10.— One-hundred-man outfit packed for shipment from an interforest cache.

Outfit, Tool, Stampede.—The outfit described here is used by Region 6 to equip members of suppression crews for fire control line construction in remote areas and for camping near their work with bed and subsistence for 3 days. The name "stampede" was applied locally to indicate that the outfit is packed and the crew ready to go at a moment's notice.

Each man's pack weighs about 30 pounds and consists of the following articles:

1 Canteen, 1-quart.
1 Mess outfit and cooking utensil.
1 Fire tool.
1 First-aid kit.
1 Headlight, with extra batteries.
1 Pack board (see fig. H-3).
Personal effects (socks, towel, soap, smokes).
3 Rations, concentrated.
12 Salt tablets.
1 Sleeping bag, light (see fig. N-4).

Each man carries a tin plate, cup, spoon, and fork. Some carry cooking utensils, which will vary in size and number with size of crew. A 2-man crew should have a 6-quart kettle and an 8-inch frying pan; a 10-man crew, two 6-quart kettles, an 8-quart kettle, and two 8-inch frying pans.

The fire tools will depend on size of crew and cover type. Tools should be balanced for efficient accomplishment of all phases of fire-fighting work.

There should be one pocket-size first-aid kit for every 2 men, and, in addition, a small-crew first-aid kit for every 10 men.

Maximum weight of concentrated rations used prior to 1943 was 11½ pounds per man. Army Ration K was used during later war years.

SECTION S

MISCELLANEOUS

Kapok Bag Roller.—This device was designed especially for rolling kapok bags, but it may be used to roll cotton, wool, and canvas materials as well. It consists of a wood frame of proper width and length for the unrolled bag, a steel shaft and handle at one end, and a movable plywood platform on which the bag is stretched. One end of the platform is hinged and the other is suspended on a wagon seat spring, which maintains pressure on the bag as it is being rolled. See plan at the end of this section. The cost is about $50.

With this equipment, kapok bags can be rolled about twice as fast as by hand and the rolls are so tight that about one-third more bags can be stored in a given amount of space. Transportation of kapok bags is also facilitated by tight rolling. This is of the greatest importance when the bags are dropped from an airplane, not only because of the saving of space, but for safety in dropping. If bags are loosely rolled there is great danger of the bundle being carried to the tail of the plane.

Kapok Bag Bundler.—This bundler consists of a pipe frame so designed that pressure can be put on the bundle of bags by means of a block and tackle. As with tight rolling, compact bundling saves storage space and facilitates transportation, particularly by airplanes.

The bundler is designed to take 4, 6, or 9 beds. Five can also be bundled with the frame set for 4. See plan at the end of this section. The cost of the bundler is about $25.

METHODS OF ROLLING HOSE

In many localities, cotton-jacketed and linen hose is rolled from the end, with the male coupling at the center of the roll. Another method, known as the "doughnut roll," is used by many city fire departments and in some Forest Service regions. By this method the hose is doubled near the center and rolled from that point, so that both couplings are on the outside of the roll, with the female coupling over the male coupling to protect the threads. The principal advantages of this method are that rolling and unrolling can be done faster and there is less danger of twisting or reversing ends in unrolling.

EYE-TEST FOR FIRE LOOKOUTS

The lookout eye-test was especially designed to select keen-eyed individuals, and to rate their relative ability to see small smokes. Keen-eyed observers have at least two advantages over less gifted ones in the detection of forest fires: (1) They are capable of seeing smoke at a greater distance, and (2) there is considerable evidence that they can detect smoke more quickly within "easy" visual ranges.

The lookout eye-test measures the ability of the observer to distinguish small individual objects, such as smokes, on backgrounds that are fairly uniform in brightness. It is superior for this purpose to such standard eye-tests as the Snellen, which utilizes different sizes of letters, because: (1) Ability to resolve the detail of images is necessary for a high score on the Snellen test, but is not necessary for the lookout eye-test or to detect smoke; (2) there is a definite physical limit to the distance at which a letter can be read, but there is not to the distance at which the black spot or a small smoke may be perceived; (3) men familiar with letters can recognize them slightly farther than men who are not; (4) different letters of the same size are not equally visible; and (5) the letters on a chart may be memorized.

The eye-test device, shown in figure S-4, consists of a 7- by 7-inch square white board with a ¼-inch black dot in the center, short black bars extending inward from each corner along the diagonals, and a 1/16-inch black spot midway between the center and one of the diagonal bars.

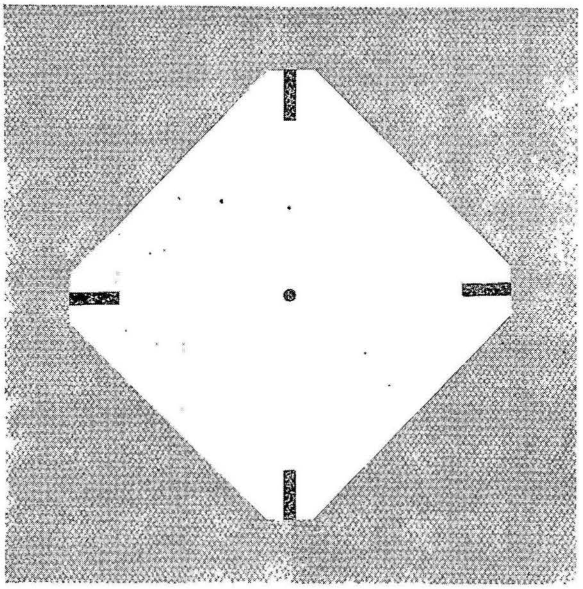


FIGURE S-4.—Lookout eye-test pattern. The stippled background is not part of pattern.

The eye-test pattern is printed on double-weight, contrasting (No. 4 or 5), smooth, glossy photographic paper. It is mounted on a backing of hard fiber board (masonite, tempered presswood, or equal, not plywood) of about ⅛-inch thickness, varnished lightly on both sides. A block about 1½-inch square and ⅜-inch thick, and drilled through the center to receive a 5/16-inch dowel handle 3 inches long in a tight fit, is glued to the center of the eye-test back.

The use of the device consists in determining the distance at which an observer can see the 1/16-inch spot. This is (1) proportional to the distance at which he can see a small smoke, and (2) independent of light intensity. The average man can see the spot about 50 to 57 feet as shown by the tabulation below. A rating of 64 or more is considered exceptional and less than 43 poor. Individuals have been tested who could see the spot as far as 95 and as little as 20 feet away.

Standards of performance and relative smoke-seeing ability for different class intervals of eye-test ratings

Performance rating	Eye-test rating *Feet*	Relative smoke visibility rating *Miles*
Exceptional	64 or more	11.0 or more
Good	58 to 63	10.5
Average	50 to 57	10.0
Fair	44 to 49	9.5
Poor	43 or less	9.0

The test should be conducted out-of-doors on level ground. Equally satisfactory results can be obtained on clear or cloudy days provided that the following simple precautions are observed: First, on clear days the target should not be in the direct sun or in deep shade, as directly under a dense tree, and second, the cloudy day should not be extremely dark. There should be a minimum light requirement of about 70 candlepower per square foot on all but the darkest of cloudy days.

Complete specifications and instructions for making and using the eye-test can be obtained from the Appalachian Forest Experiment Station, Asheville, N. C., which also has available for temporary loan master negatives for the target pattern.

MAP MOUNTING

Mounting Maps on Metal or Wood

The following instructions will be found helpful in mounting lookout maps, dispatcher maps, etc., and if followed carefully a satisfactory job of map mounting can be done by anyone:

Osborne fire-finder map disks.—Fire-finder maps should be mounted on 24-gage galvanized iron disks, which should be perfectly flat, cut to the exact size for the fire finder, and with the rough edges ground off. The maps should preferably be lithographed on good quality paper. Blueprints and black-line prints are undesirable because they are apt to have an excessive amount of distortion. If it is desirable to use two maps of different scales, they may be mounted on opposite sides of a single disk. A satisfactory method of preparing and mounting a map is as follows:

1. Ascertain the precise position of the lookout station on the map and make a 1/16-inch hole at this point to facilitate centering the map on the disk in mounting.

2. Using red ink, draw a true meridian through lookout point. The length of this line should equal the diameter of the disk.

3. Write township and range numbers on the

Note: Page numbers S-3 and S-4 are missing.

map, together with any other written additions or corrections to be made, using black india ink.

4. Cut out the map on a radius one-sixteenth of an inch shorter than the radius of the disk.

5. Drill a 1/16-inch hole through the exact center of the disk and lay the disk on a table with a pin protruding through the hole.

6. Using a varnish brush, apply a thin, even coat of white shellac to the disk and the back of the map, and allow the shellac to dry for several seconds until it becomes slightly sticky.

7. Grasp the map by the edges and center the lookout position by means of the protruding pin and hole in the map; allow the center to sag into contact with the disk, then gradually lower the edges so that the map falls into place without stresses. Work rapidly, as shellac becomes very sticky in 2 or 3 minutes.

8. Work over the entire surface of the map from the center outward, using the hands or a folded cloth to press it into contact. Remove air bubbles by pricking through the paper and forcing the air out. Do not use a roller when map is first laid and do not attempt to work air bubbles to the edge of the disk, as this will cause distortion.

9. To protect the map surface, first apply a very thin coat of spar varnish or shellac and allow it to dry for about 24 hours, then apply one or two coats of spar varnish. Shellac is undesirable as a top finishing coat because it is apt to turn white when exposed to moisture or to sunshine. Care must be exercised in applying the first thin coat, as too much varnish will turn the map transparent and too much shellac or brushing of shellac will cut the drawing inks used and cause them to run or smudge. To secure a clear, smooth luster on the surface and remove the sticky feeling after varnishing, use a good grade of polishing wax and polish thoroughly.

The cost of time and material for single mounting is about $1.50 per disk; for double mounting about $2.50.

Mosquito

Bosworth fire finders. — Maps should be mounted upon Bosworth map boards in the same manner as upon Osborne fire-finder disks. However, a more desirable arrangement for the Bosworth fire finder is to use a galvanized-iron disk, similar to the Osborne disk, and cut to a diameter which will just fit inside the brass azimuth ring hold-down screws and yet allow the ring itself to rest upon the edge. In this manner the map can be mounted upon the light metal disk and taken to the lookout where the fire finder is used and properly centered and adjusted to the Bosworth board top with ease, requiring only a screwdriver to do the job.

Metal-backed dispatcher or platting maps.— Platting maps should be mounted on a single sheet of 14-gage perfectly flat galvanized iron in the same manner as fire-finder maps are mounted. After mounting is completed the metal sheet should be screwed to a board or table top.

Before the map is mounted, true meridians should be drawn through the centers of all lookout positions. If a dispatcher's protractor is to be used for platting, the meridian should extend north from the lookout position 6 to 10 inches. Should a lookout position be near the top of the map, the meridian may be drawn to the south. Red ink is preferable for meridians, but if several lookout positions are close together, different colors should be used.

Meridians must be drawn with the utmost precision, as an error in alinement of a meridian will result in a corresponding error in all plattings made from it. A convenient method of drawing an accurate meridian is as follows: Lay a sheet of paper on the map so that its edge cuts through the lookout point as a straight east and west line. Mark on the edge of the paper the exact position of the lookout point and of the nearest meridian lines to the east and west. Move the paper toward the top of the map 15 to 20 inches, match markers to meridian lines, and make a dot on the map opposite the lookout marker. A straight line from this dot through the lookout position will be a true meridian. On account of the convergence of meridians the edge of the paper must be angled slightly at the upper setting to match the markers.

After the map has been mounted and before the protecting coats of shellac and varnish have been applied a hole should be drilled through the metal at the exact center of each lookout position. This hole should be made with a drill of the proper size according to size of pin in protractor to be used for platting. Before drilling, the point should be marked carefully with a sharp center punch. After the map has been shellacked and varnished the holes should be reamed with the drill.

Metal platting boards with maps mounted by this method cost about $1 per square foot, including material and labor.

Wood and fiber map boards.—Maps should be mounted upon wood and fiber boards in the same manner and using the same materials as for mounting upon metal. Soft fiber boards which are not printed should be given two heavy coats of shellac which should be allowed to dry and set thoroughly before mounting the map. Unfinished wood surfaces should also be treated to one coat of shellac before mounting the map; otherwise the wood absorbs so much of the mounting shellac that the map may not adhere tightly and evenly throughout.

White background for maps.—Where a lasting white background is desired for a mounted map, the board upon which the map is to be mounted, whether metal, fiber, or wood, should be given one or two coats of first-quality white paint or enamel of the type suitable for applying to the base material to be used. In the case of the Osborne fire-finder disks, Bosworth fire-finder tops, and metal boards of any kind, a good grade of white iron enamel will prove most satisfactory. After the base is painted, allow it to dry for several days to make sure the paint becomes entirely hard and thoroughly set. Before mounting the map, sand the painted surface lightly with very fine sandpaper to take off the glaze and to smooth down any small bubbles or paint points.

There is less danger of having a map turn transparent on this type of mounting than when maps are mounted directly upon natural-finish metal, wood, or fiber backings.

Mounting Maps on Cloth Backing

Procedure.—Cotton sheeting should be used in the mounting of maps. This sheeting may be purchased in various widths, but the 90-inch and 72-inch widths are most economical and practical for use when large maps must be mounted or when there are large quantities of smaller maps which should be mounted at one time.

The dry sheeting is stretched tight on a smooth board of sufficient size to accommodate the map or maps to be mounted. The maps should be dipped in a tank of water and placed face down on an adequate sized board, allowing the surplus water to drain off. The paste is spread evenly over the back of the map, care being taken to cover the entire surface. The map is then placed face up on the dry sheeting and smoothed down carefully, first, with the hands and, finally, with a rubber roller. The map should dry overnight before it is removed from the board. If removed before it is *thoroughly* dry it will not lie flat.

Paste.—Dissolve 2 pounds of lump laundry starch in about 1 pint of *cold* water. Pour over this mixture 1½ or 2 gallons of boiling water, stirring until thick. A smaller quantity of paste may be made if desired. A larger quantity is not recommended as it becomes sour if kept too long. Paste should be strained through cheesecloth before using, to remove all lumps.

Splicing and Mounting Maps—Paper to Paper

A cement product similar to Para-Lastik will be found very satisfactory in paper-mounting work of any kind. It is especially suited to mounting maps on paper backings or for splicing two maps or other similar pieces of paper together. It is on the order of rubber cement, but is much more efficient in that it does not allow the spliced pieces to be pulled apart as readily as does regular rubber cement.

In using this cement, both surfaces of the papers to be spliced or mounted should be covered with a thin but even coat. This should be allowed to dry until quite sticky and then the papers put together in the position in which they are to remain. After adjusting the splices to their true positions, the two pieces should be firmly pressed into place, weighted with several pounds of weight, and allowed to dry for several hours. Care should be taken to see that the spliced pieces do not shift at the time the weights are placed.

Ordinary rubber cement can be used in the same manner, but it will not prove nearly as satisfactory. Splicing done with either Para-Lastik or ordinary rubber cement may be taken apart after an elapse of several weeks without damage to either the piece of paper or map.

Both Para-Lastik and ordinary rubber cement are very easy to handle because excessive cement which oozes out around the edges of the spliced pieces may be removed very easily with ordinary draftsman's art gum or other type of soft eraser without leaving any marks upon the map, paper, or whatever it is that is being spliced or mounted.

WATERPROOFING MAPS, PHOTOGRAPHS, ETC.

Maps, photographs, and other paper can be weatherproofed very satisfactorily by coating with a compound solution of acetone and plastacele or xylonite. About the same amount of acetone should be used as would be required if paint or varnish were to be used to coat the same surface. Enough xylonite or plastacele, cut into small chunks or strips, should be dissolved in the acetone to make a sirupy mixture. There is no set proportion that will result in the desired consistency. The solution should be shaken often while the plastacele or xylonite is dissolving.

When ready for use, the solution should be applied to the map, photograph, or other surface with a fine camel's-hair brush and allowed to dry thoroughly. Two coats on both surfaces will give a thoroughly waterproof job.

While being mixed, the solution should be kept away from fire or flame, since acetone is highly inflammable. Xylonite also burns readily, but plastacele will not burn unless exposed to direct flame and then it will melt slowly. The solution should be tightly corked after preparation because it evaporates very rapidly and will set in solid form within a short period.

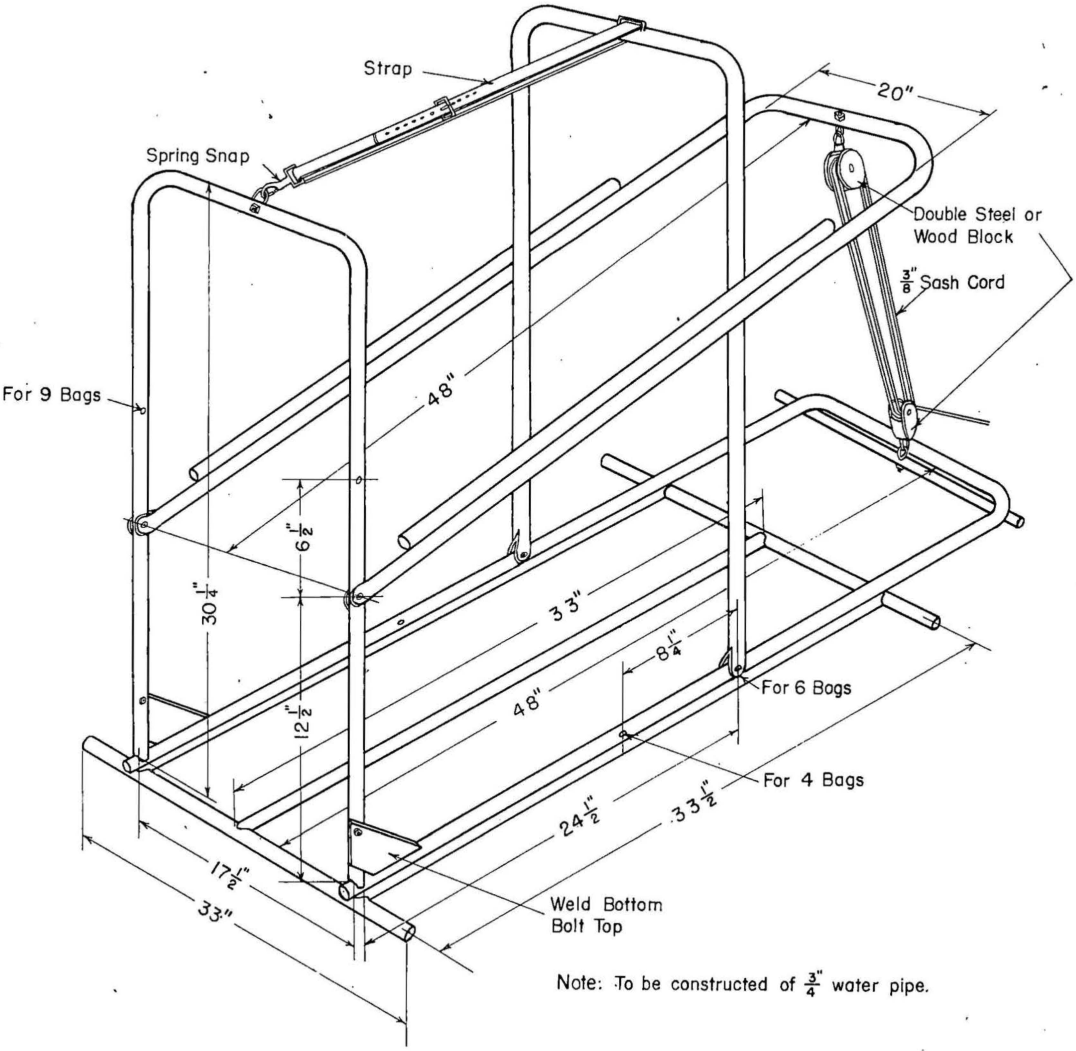
The same solution can be used instead of varnish for covering lookout maps. It is colorless and transparent, and if two or three coats are applied, the map can be written upon with pen and ink or pencil and the marks readily washed from the surface with a wet rag, dipped in soapy water if necessary.

Acetone can be procured from any drug store, and if required in large amounts, can be obtaintd wholesale at about $1 per gallon.

Plastacele dissolves rather slowly and it may be several hours before it is ready for use. Xylonite dissolves more readily. Celluloid or pyrolin can also be used to make this solution, but are not recommended because of their high inflammability, which makes the item coated highly susceptible to burning if brought into contact with a lighted cigarette, match, or other flame or fire.

BADGE, WARDEN

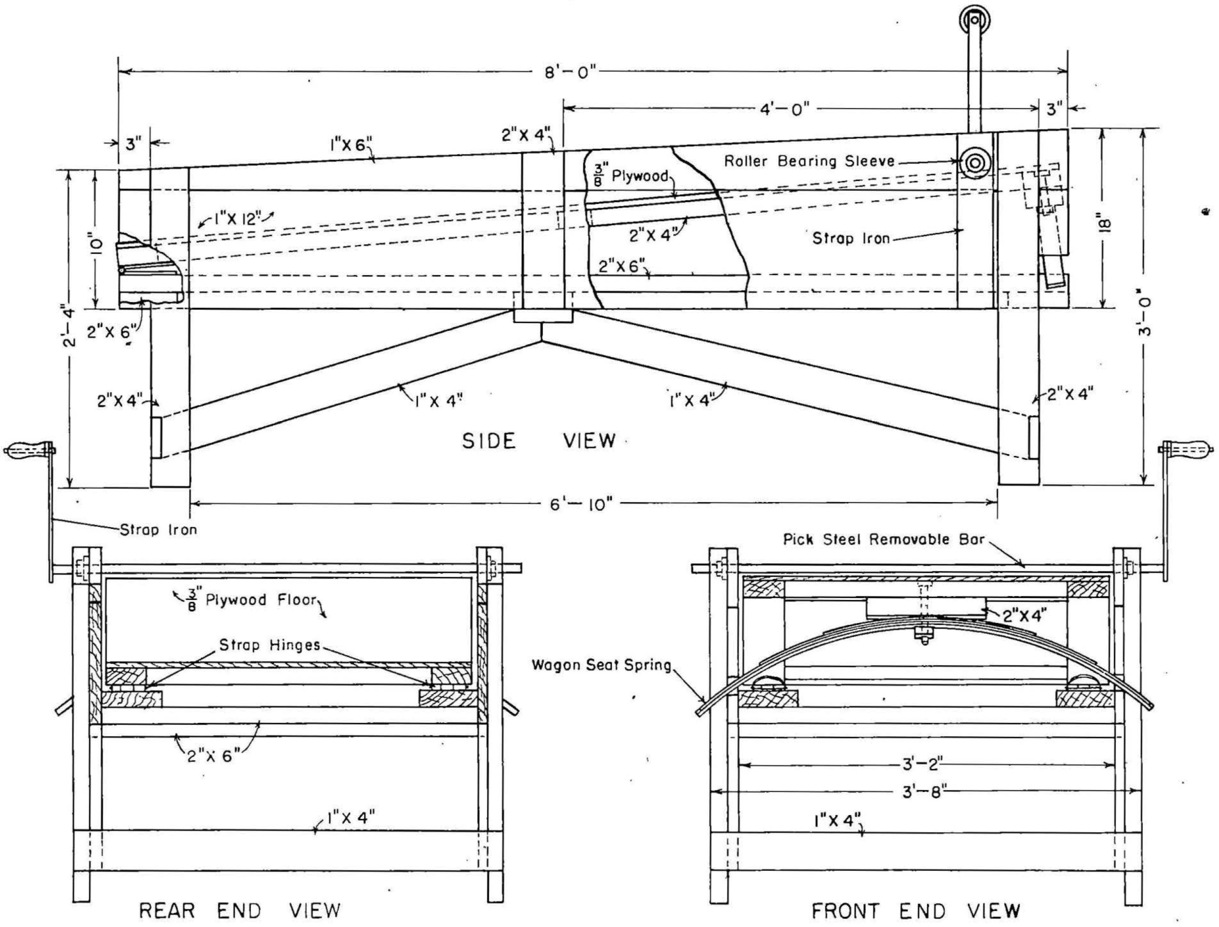
This is a shield-shaped forest warden badge used extensively in the eastern regions. It is generally given cooperative fire-crew leaders who are directly responsible for first call when a fire occurs. Many of the States use their own individual fire warden badges to designate cooperators. All warden badges are of bright metal with appropriate symbols and wording. They remain the property of the issuing agency. Most wardens are very proud to have the badge issued. In general, it aids in creating a much better cooperative effort wherever used. Approximate cost, 25 cents.


Strap
Spring Snap
20"
Double Steel or Wood Block
3/8" Sash Cord
For 9 Bags
48"
6 1/2"
30 1/4"
33"
8 1/4"
For 6 Bags
48"
12 1/2"
For 4 Bags
24 1/2"
33 1/2"
17 1/2"
33"
Weld Bottom
Bolt Top

Note: To be constructed of $\frac{3}{4}$" water pipe.

KAPOK BAG BUNDLER

L.G.G.–U.S.F.S., W.O., 1947


8'–0"
4'–0"
3"
3"
1"X 6"
2"X 4"
$\frac{3}{8}$" Plywood
Roller Bearing Sleeve
1"X 12"
2"X 4"
2"X 6"
Strap Iron
10"
18"
2'–4"
3'–0"
2"X 6"
2"X 4"
1"X 4"
1"X 4"
2"X 4"
SIDE VIEW
6'–10"
Strap Iron
Pick Steel Removable Bar
$\frac{3}{8}$" Plywood Floor
Strap Hinges
2"X 4"
Wagon Seat Spring
2"X 6"
3'–2"
3'–8"
1"X 4"
1"X 4"
REAR END VIEW
FRONT END VIEW

BILL OF MATERIAL

LUMBER

1 Piece	Plywood $\frac{3}{8}$" X 3'–2" X 8'–0"
2 Pieces	1" X 12" X 8'–0"
2 Pieces	1" X 6" X 8'–0"
2 Pieces	2" X 6" X 8'–0"
3 Pieces	2" X 6" X 3'–2"
2 Pieces	2" X 4" X 8'–0"
3 Pieces	2" X 4" X 3'–2"
2 Pieces	2" X 4" X 14"
2 Pieces	2" X 4" X 2'–4"
1 Piece	2" X 4" X 12"
2 Pieces	2" X 4" X 3'–0"
2 Pieces	1" X 4" X 3'–8"
4 Pieces	1" X 4" X 4'–6"
1 Piece	2" X 6" X 3'–8"

HARDWARE

1 Piece Pick Steel, 40", Ground to Taper
1 Piece Strap Iron, Fulcrum of Handle
1 Handle, Roller Type
2 Roller Bearings
2 Pipe Sleeves
1 Steel Spring, Wagon Seat Type
2 Strap Hinges, 8"
12 Bolts $\frac{3}{8}$" X 4"
6 Bolts $\frac{3}{8}$" X 10"
24 Bolts $\frac{1}{4}$" X 3"

KAPOK BAG ROLLER

L.G.G. – U.S.F.S., W.O., 1947

SECTION T

CARE OF EQUIPMENT

IMPORTANCE OF MAINTAINING EQUIPMENT

It is just as important to plan acquisition, maintenance, and location of equipment on the basis of actual hazard and risk as to recruit and train the protection personnel. Both are necessary to a first-class fire control organization.

Many fires have been lost because equipment has lacked inspection and adequate maintenance. It is particularly important throughout the fire season to service all equipment items and return them to their proper locations promptly after use. In off seasons they should be thoroughly serviced, tested, and stored in accordance with approved local practice and standards.

From the outlying warden tool cache to the 20-ton trailbuilder, some fully qualified employee should be assigned individual responsibility for the maintenance of specified equipment, its storage, and its location when needed on fire call.

It is not practical to cover complete maintenance details for each of the handbook items. A partial list of items and some of the more important maintenance jobs which can be handled by the average fire employee have been included. Maintenance which requires skilled techniques and jobs covered by special handbooks have been omitted.

FIRE DANGER EQUIPMENT

To obtain reliable fire danger records, the instruments must be properly exposed and maintained. Exposure will usually be supervised by a forest officer, but maintenance is the observer's responsibility.

Fuel-Moisture Sticks

Reliable readings of fuel moisture will be obtained if the following points are observed:

1. Never handle fuel-moisture sticks with sweaty, dirty, or greasy hands. Excessive handling clogs the wood pores and prevents ready response to atmospheric changes.
2. Handle carefully to avoid splitting, chipping, or marring.
3. If dust or dirt of any kind should get on the sticks, brush it off lightly with a clean, dry cloth or soft brush.

Fuel-Moisture Scale

This instrument requires no special care except to handle as a precision tool. Do not oil the pivot; it is made of hard nickle silver and requires no lubricant.

Anemometer

The anemometer should be oiled once a month with a high-grade light instrument lubricant. Whale oil is the very best, but good typewriter oil is satisfactory. The buzzer type anemometer should be oiled at the top and bottom of the spindle. When the cups are removed, a drop or two of oil may be applied to the top bearing. The face plate must be removed to reach the bottom bearing on which the spindle rests. Do not use an excessive amount of oil. Anemometers should be taken down and carefully cleaned once a year.

Rain Gage

The rain gage must be kept level. Check funnel to insure that it has not been bent. Clean out all debris, such as leaves, needles, and insects regularly.

DETECTION EQUIPMENT

Osborne Fire Finder

Other than normal care in handling, this instrument requires lubrication only. The sight-bearing rig and leveling screws should be lubricated periodically with a light oil or vaseline.

Binoculars

Lenses shoud not be exposed to direct sunlight, as continued exposure destroys the seal between the lenses. Clean lenses with soft cloth or tissue to avoid scratching.

COMMUNICATION EQUIPMENT

Certain items of maintenance in connection with the use of the radio and telephone which do not require technical attention, but which contribute materially to good service are given below.

Radio

1. Handle the set carefully; caution drivers and packers against rough handling; avoid unpadded transportation in rough-riding vehicles.

2. Protect set from dampness, excessive heat, and dust. Sets stored for the winter should be kept in a dry place.

3. Report failures promptly and avoid tampering.

4. Mark plainly all sets in need of repair, so they will not be sent out in unsatisfactory condition.

Telephone

1. Make connections carefully; see that binding screws are tight.

2. Avoid careless stringing of emergency lines or emergency connections to permanent lines; fasten securely in place.

3. Renew batteries at least annually and date at time of installation. Test periodically.

4. Protect set from dampness and excessive heat. Sets stored for the winter should be kept in a dry place with batteries removed.

CANVAS GOODS

Much canvas is used in fire control activities and its upkeep needs careful consideration.

Canvas mildews quickly under conditions of warmth, absence of light, and a moist atmosphere. When it has lain for some time on a damp floor bacterial action takes place. This produces no change in color but weakens the fabric. Destructive chemical action is caused by action of air and moisture alone under the influence of sunlight. Folding of heavy canvas may weaken or crack the material, particularly if it is stiffened by freezing or waterproofing treatment.

The more common preventive measures which can be taken to prevent loss from these causes are:

1. Expose to the sun as little as possible. Tents should be taken down when not needed.

2. Fold to protect wearing surfaces: (a) lay tent flat; (b) fold ends square with sidewalls; (c) fold roof flat over sidewalls; (d) fold again from top edge toward bottom. Continue to fold until width of fold is not greater than height of sidewall, then roll or fold to desired shape. Folded this way, the roof, the most important part, is protected by the sidewall and only the lower part of the sidewall is exposed to wear and tear in storage or shipping.

3. Canvas should be thoroughly dried before storing to avoid rot.

4. Store canvas on racks or ventilated platforms or hang it up. Don't leave it on the floor.

5. Protect it from rodents.

6. Torn canvas should be repaired promptly. Neglect will usually result in complete loss. Flexible canvas patching compound is available commercially and can be used effectively to form a water-tight seal over small holes or tears.

WATER CONTAINERS

1. Care should be taken to see that no water remains in containers when they are in storage. Unless they are thoroughly dry, they should be allowed to stand upside down until it is certain that all water has been drained.

2. Inspect for cleanliness before use. If objectionable odor is detected, wash out with soda and warm water.

3. Put a small amount of talcum in rubber insert bags after drying to prevent sticking. Small holes may be successfully repaired with vulcanizing tire patches.

4. Store containers in a cool, dry place.

5. Refer to "Care of Canvas Goods" where applicable.

LEATHER GOODS

Leather goods should be kept clean and pliable for maximum life and serviceability, and good appearance. Some methods of doing this are described below.

Mildew

Any leather article will mildew if kept in a warm, damp, dark place. While mildew will not reduce serviceability of leather unless it remains too long, it will change the color and injure the appearance. To prevent mildew, keep the leather in a well-ventilated, dry, well-lighted place. If mildew develops, wash it off with soap and warm water or wipe it off with a moist cloth. Dry the leather well afterwards. Do not use preparations designed to prevent the growth of mildew.

Brittle Leather

First soak the leather in clear water until soft, then wrap it in burlap or porous cloth for slow evaporation. The following day treat the damp leather with appropriate grease or oil. If the weather is hot and dry, thoroughly wet the burlap or cloth to make sure the leather will be damp the next day. If it should dry out overnight, do not oil or grease it until it has again been wrapped in wet cloth for several hours.

Saddles

Cleanse the saddle thoroughly with tepid water and a lather of saddle soap or any other soap that is free from acid and alkaloid, such as genuine castile. Apply the water and lather with a sponge or a soft cloth. While the leather is still damp and warm, rub on a succession of coats of warm, but not hot, neats-foot oil. Rub the oil well into the leather, continuing until the leather will absorb no more. Let the saddle hang in a warm place for 24 hours, wash again with tepid water and a lather of neutral soap in order to remove the oil residue. If the oil has been thoroughly worked into the leather and the leather has been carefully washed, there will be no likelihood of soiled clothing when the saddle is used. This method is recommended by two manufacturers of saddles in different parts of the country. Neither of them recommends petrolatum, viscol, or vegetable oils for saddle dressing.

Harness and Miscellaneous Leather Gear

In washing the leather, use tepid water, a neutral soap, such as castile, and a sponge or fairly stiff brush. Remove all hardened grease and caked dirt by scraping. After washing, rinse leather in clean, tepid water, then hang it in a warm place until it is no longer wet but still damp. In that condition it is right for oiling or greasng. Dry leather may take up so much grease that it will pull out of shape.

A mixture of neats-foot oil and tallow is an excellent dressing for harness. It is improved if mixed with enough wool grease to make a paste about as thick as butter. In case the greases and oils mentioned are very expensive or difficult to obtain in sufficient quantities, they may be mixed with equal parts of heavy mineral oil, or paraffin, or a mixture of these materials.

Heat the oil or grease mixture until it is just comfortably warm to the hand and apply it liberally to the damp leather, rubbing it in thoroughly. Hang the harness or other article in a warm place overnight, then rub off the excess oil with a clean dry cloth.

HAND TOOLS

Sharpening Tools

There are various methods of sharpening tools which will produce a satisfactory cutting edge. Opinions vary as to proper methods. No attempt is made to settle controversies here; however, there are certain basic principles in sharpening tools which can be set forth briefly as general information.

Dry Grinding

There is a popular belief among field men that edged tools, such as axes and brush hooks, cannot be sharpened properly with dry grinding wheels such as axolite and carborundum. This idea antedates the introduction of the manufactured abrasive used in grinding wheels and is a relic of the days of the wet grindstone. A canvass of leading Pacific coast grinding companies establishes the fact that practically all but special grinding work can be done with dry wheels. Edged tools, such as axes and the other types of hand tools used in forestry work, can be ground dry. Grinder-wheel manufacturers can provide dry grinding wheels suitable for any class of work.

The most satisfactory power grinder wheel for ax grinding, in the 1½- by 10-inch size, is the 36–W–M. This wheel is a free-cutting, cold type —which does not mean that the tool will not get warm but rather that it will not get hot. Only moderate pressure should be applied to the tool as it is ground. It should be moved so the grinding will not be concentrated at one point and dipped in water occasionally to prevent overheating. No tool should be ground so rapidly that it becomes too warm to handle comfortably. The thinner the blade, the greater the care needed in grinding to keep the tool heat within proper limits. The cutting edge of an ax or similar tool should be ground with extreme care. The best practice is to finish the cutting edge on a wet grindstone.

Dry grinding wheels leave a wire edge on tools the same as wet grindstones. Such an edge is not suitable for cutting, as it soon turns over and leaves the tool dull. All edged tools should be whetted with a hand stone after they are ground to remove the wire edge. A tool with a wire edge is susceptible to chipping or nicking, especially if used in hard wood or knots.

Wet grinding

This method is, of course, by far the safest, and it is to be preferred where men who have had no previous experience in tool grinding are employed. The only disadvantage of wet grinding over dry grinding is the slower cutting speed of the stone. It has an important advantage where inexperienced men are used, as the temper of the tool cannot be affected. Probably the most satisfactory all-round method is a combination of dry and wet grinding, if the men are experienced.

It is desirable to employ as tool sharpeners men who are not only experienced in grinding but who are familiar with the particular tools to be ground and their intended use, because overheating is not the only result of improper grinding of axes or other tools. Shape and thickness of the bit and bevel of the cutting edge must be correct, and these vary with type of work and tool.

Filing

This method of sharpening edged tools is satisfactory, provided the work is properly done. It is, however, a tedious process and tools so sharpened usually have "dubbed-off" cutting edges, which require heavy grinding to restore them to proper shape. Filing is not advocated except as a temporary expedient. To avoid personal injuries, tools filed should be secured in a convenient position and the file should have a handle.

Axes and similar edged tools

The shape to which cutting bits and edges are sharpened depends entirely upon the type of tool and the work to be done with it. Axes should always have an even rolling bit, the thickness depending upon type of chopping to be done. Beveled tools should be ground or sharpened to retain a proper bevel, because bits grow shorter through wear. Dubbing-off is a common fault when tools are sharpened hurriedly or by inexperienced men. The use of tools with dubbed-off cutting edges causes loss of time and accidents.

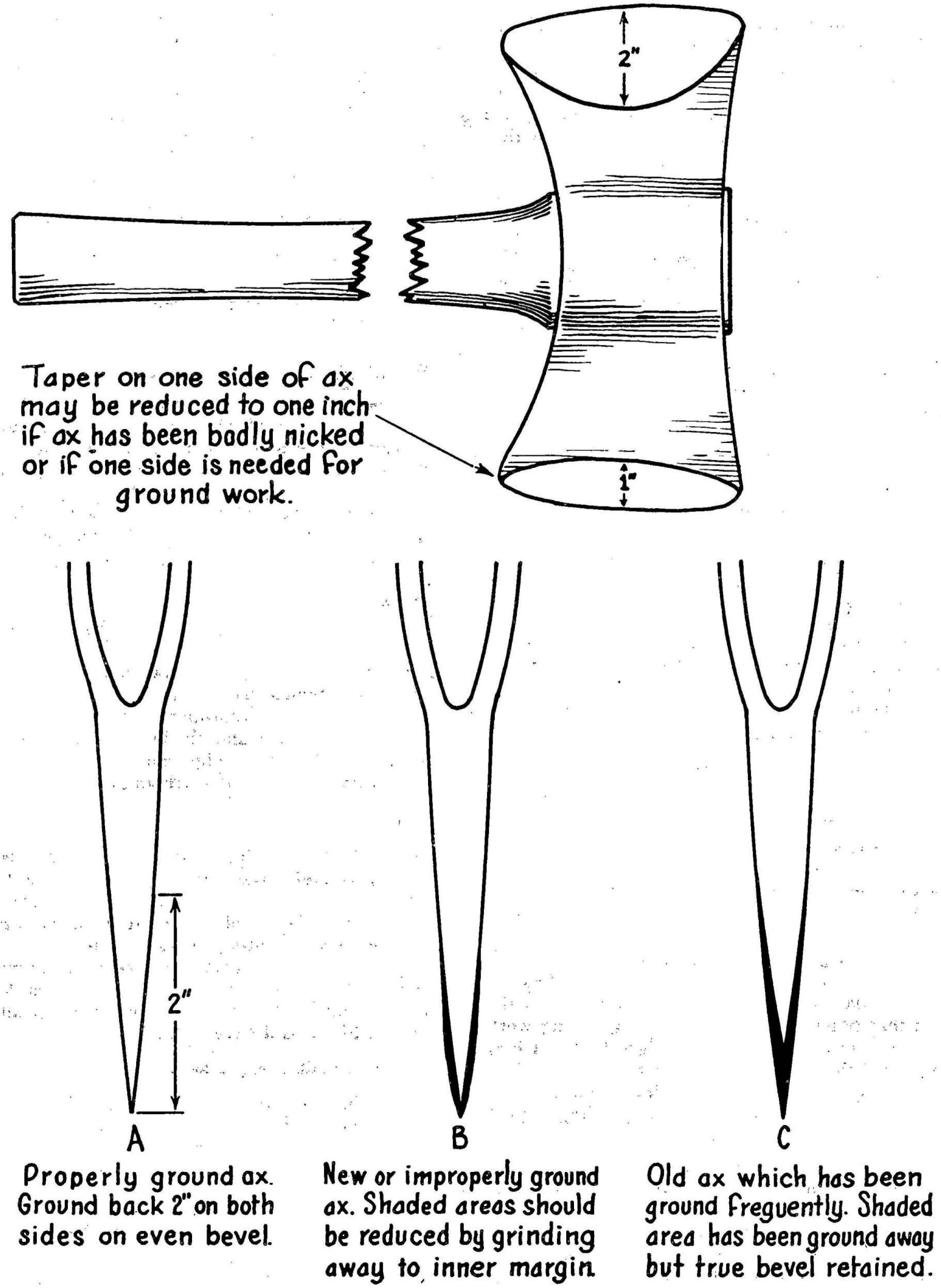

2"
Taper on one side of ax may be reduced to one inch if ax has been badly nicked or if one side is needed for ground work.
1"
2"
A
Properly ground ax. Ground back 2" on both sides on even bevel.
B
New or improperly ground ax. Shaded areas should be reduced by grinding away to inner margin.
C
Old ax which has been ground frequently. Shaded area has been ground away but true bevel retained.

FIGURE T–1.— Ax sharpening procedure.

Figure T–1 illustrates common conditions and recommended procedure for correctly shaping and sharpening an ax. Grind fan-shaped on even taper for 2 inches back from the edge. Cutting edge must be in direct line with center line of handle. Taper on one side may be reduced to 1 inch if ax has been badly nicked or one side is needed for rough work.

Grub hoes and similar digging tools

Use files or grinders to sharpen tools of this group which are only slightly blunt or dulled on the edges. The average mattock or grub hoe bit is at proper angle if the ground or filed face is approximately one-half inch deep. The hazel hoe and adz hoe cutting bit is at proper angle if the ground or filed face is approximately three-eighths of an inch deep. Do not grind or file the edge of the outside face of any of these tools. (Refer to fig. T–2.)

Very dull tools of this class can be properly sharpened only by heating and reshaping with a hammer, followed by treatment as just described. Heating and reshaping requires the skill of an experienced tool dresser and is not to be undertaken by a novice.

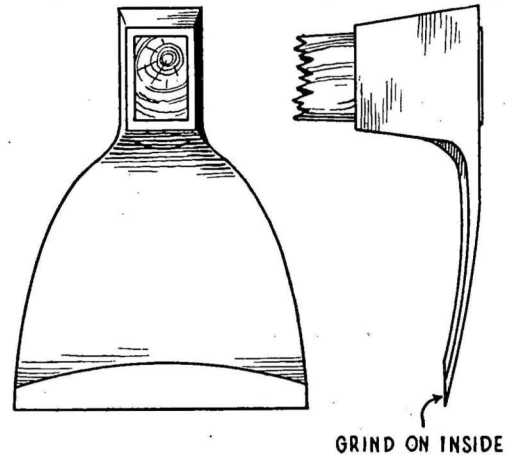


Figure T–2.— Properly ground adz hoe.

It is not considered advisable to sharpen the hoe end of Pulaski tools by heating and drawing because of their thin construction and the high-grade tool steel used in them. Properly ground bits are equally as satisfactory as drawn bits. Therefore, there is nothing to be gained by forge heating and hammer drawing; if not properly done there is much to be lost.

Thin-bladed saw-steel hoes, McLeod tools, etc., should always be ground sharp. It is even inadvisable to draw thin-bladed hazel hoes except in special instances and when the work can be done by an experienced tool sharpener.

Shovels

While rarely done, it is desirable to sharpen shovel blades to a good, keen bevel not too thin or long. This can be done very easily and quickly with an emery stone or by filing.

Crosscut saws

Sharpening crosscut saws requires skill and experience. Therefore, it is both difficult and impractical to write a set of instructions which anyone can follow and perform a satisfactory job. Manufacturers have bulletins available which set forth the guiding principles for saw filing. The important thing is to employ experienced and competent saw filers.

Rehandling Fire Control Tools

Just as there are different ways of grinding fire control tools, so there are various satisfactory methods of rehandling tools. However, there are a few basic principles which should be adhered to regardless of the method employed. A few of the more important pointers concerning the rehandling of fire control tools follow:

Axes, brush hooks, Pulaskis, sledges, etc.

The first step should be to remove the old wedge from the handle. After removal of the wedge, the handle should be cut off with a saw or chisel flush with the inner edge of the eye and the stub driven out toward the outer end of the eye. This direction is preferred since most axes and similar tools which are nonreversible are provided with tapered eyes, the outer end being the larger opening. A steel mandril slightly smaller than the tool eye and slightly concave at the driving face is satisfactory for this purpose. The concave face tends to draw the wood together and away from the sides of the tool eye.

The new handle should be shaped to fit the eye perfectly throughout. The best method of shaping is to use a spoke- or drawshave for the heavier work, finishing with a wood rasp. During the fitting process the handle should be tried in the eye frequently, driving it in with a wooden mallet and then removing it to determine high spots. If an old tool is being rehandled, the high spots will be indicated by rust, and if a new tool, they will be disclosed by shiny spots on the handle.

After the handle is properly fitted to the eye and driven in place so that the inner edge of the eye is about one-half inch from the shoulder of the handle, the outer end should be sawed off flush with the eye and split longitudinally through the center with a wide-blade chisel. A suitable wedge, thoroughly seasoned, should then be driven into the split end of the handle. The wedge should be constructed from straight-grained material and should be long, thin, and evenly tapered.

The type of wood to be used for wedging tool handles is the subject of some controversy. However, most experts agree that the most desirable type is straight-grained maple and that the second best is a strong, tough, straight-grained softwood similar to pine or spruce.

Short, thick wedges should never be used because they provide insufficient bearing surface, which tends to permit the handle to work loose.

Moisture content of handles and wedges

Probably the most efficient moisture content for insuring a tight handle without causing weakness is 12 to 15 percent. Handles with a lower moisture content are apt to be somewhat brashy and may break more readily at the eye. Handles with a higher moisture content are apt to become loose in a short while.

Loose handles

The loose-handle problem, particularly with axes, brush hooks, and similar broad-eye tools is ever-present. It may be helpful to analyze briefly the mechanics involved in handling tools and keeping them tight. First, there is an eye shaped of metal which does not exert any springing effect on the handle. It is solid resistance. The handle is live wood, it has the property of returning to its shape after being compressed if the pressure applied has not been great enough to crush the cell structure of the wood. Also the wood has hygroscopic qualities; it will pick up moisture from the atmosphere and return it to the atmosphere, depending on the relative humidity. It is this action which causes handles to become loose during midseason. During the winter months the handles absorb liberal quantities of moisture in various cycles, depending on the moisture content of the surrounding air. This expansion within the eye is great enough to crush the wood cells on the surface. Subsequent loss of moisture causes the handle to shrink, and the initial looseness which develops is the result of smaller size due to the crushed cells.

The best known cure for loose handles is to remove the old wedge and rewedge with a satisfactory type of new, wooden wedge, or, if not too loose, to reset the old wedge.

Soaking loose handles.—As a temporary expediency, soaking handled tools in water will tighten the handles so that they will be serviceable for a short while, but in the long run, this method of tightening handles does more harm than good, as they soon loosen to a greater extent than before they were soaked. Also, it tends to introduce rust between the metal and the wood which breaks down the cell structure of the wood and causes still further loosening of the handle.

Tightening handles with oil. — Boiling tool handles in linseed oil or otherwise soaking them in oil solutions merely aggravates the loose-handle difficulty. They may remain tight for a short period after such treatment, but like soaking in water, the treatment in the long run is worse than no treatment at all. The oil impregnates the wood, seals the cells, and produces a brashy condition in the wood fiber. Also, a lubricant has been placed in the eye which tends to permit the handle to work loose more easily.

Hoes and similar tools

These tools should have the handles carefully fitted to preserve true alinement and to insure an even and solid fit through the entire tool eye. A wood rasp is the best for shaping. Handles should be tested in the same manner as suggested for axes, by driving into place and then removing to insure an even fit through the eye. It is essential to secure a perfect fit, otherwise "rocking" of the tool head is very likely. Tools which are slipped on over the entire length of the handle should be fitted so that about one-half to three-fourths of an inch of handle protrudes through the eye when first fitted. This will allow for wear and subsequent tightening of the handles by driving farther into the head of the tool. Wedges of any type should not be used in handling these tools.

Rakes, etc.

In some cases it is desirable to procure handles which have the steel ferrules already fitted. Tools of this kind ordinarily should be rehandled in a shop where a vise, rasp, brace, bits, file, cold chisel, rivets, and hammer are available. The handle should be carefully sized to fit evenly throughout the length of the ferrule.

Shovels

It is neither practical nor economical to rehandle shovels. The only material salvage possible from broken shovels is the blades, which can often be used for making up other tools where a machine or blacksmith shop is available.

Oiling or Greasing Fire Control Tools for Storage

Of the various articles of fire control tools, only saws, axes, Pulaskis, brush hooks, and similar cutting tools need be greased. Except in certain locations, where they are particularly subject to rust, it is not considered economical to grease rough tools, such as shovels, rakes, hoes, and mattocks. Mineral oil is recommended as a rust preventive for saws.

Before oiling saws or other tools, be sure to remove all accumulated rust or coatings of pitch. Steel wool is effective for this purpose. Rust on axes can be easily ground off. In applying grease to edged or pointed tools, make sure that the extreme points and edges are coated.

If a more lasting rust preventive is required, or one which will not rub off readily, a thin coat of either boiled linseed oil or cosmoline may be used. Boiled linseed oil will wear off in a satisfactory manner as soon as the tool is put to use, but cosmoline becomes tacky and difficult to remove if allowed to stand for a long period.

PUMPING EQUIPMENT

Pumpers

Only experienced operators should be entrusted with the operation, maintenance, and general care of pumper equipment. A reasonable working knowledge of the mechanics of pumpers is essential to proper operation. Too often operators do not have such knowledge, and as a result, pumpers give faulty performance and, in many instances, are mistakenly condemned.

No attempt is made to list here the maintenance requirements for each type of pumper, but a few facts that apply generally are given.

Routine tests

Pumpers should be operated at least once each month during the field season as a check on serviceability and the training of operators.

In trial or check runs with auxiliary powered pumpers, insure adequate test run periods to allow the engine to reach normal operating temperatures. Avoid application of full load until normal operating temperature is reached. Abnormal wear can occur during this warm-up period, which could not be justified except in an emergency.

Packing glands on pump shafts should be permitted to leak slightly, as passage of water through the packing assists in lubricating the shaft and results in cool operation of the bearing.

Watch oil pressure and water temperature gages, if provided. If not, check water jacket temperatures periodically to insure that the engine is not overheating.

High engine speed at no load should be avoided. The excessive vibration caused by this practice can be injurious to both engine and pump.

Two-cycle engines, where the lubricating oil must be mixed with the fuel, should be stopped by closing the carburetor inlet valve. This permits the carburetor float chamber to empty and prevents settling of the oil which is in suspension in the fuel; usually a cause of difficult starting when the engine is cold.

Portable Pumpers

Strain fuel, whether clear or oil mixed, through a filter-type funnel with 200 to 250 mesh screen or a chamois skin. Measure the oil carefully when mixing it with gasoline for two-cycle units. The two-cycle portable pumper is one of the most intricate pieces of equipment used in fire control work. Treat it properly and it will perform accordingly, mistreat it and it will be quickly ruined.

Install a relief valve near the discharge outlet, if one is not built in the pumper. Without a relief valve a kink in the hose line may result in serious damage to the pumper before the hose fails.

Storage

After a pumper has been cleaned and repaired at the end of the fire season, it should be thoroughly dried and oiled before storing. Spark plugs should be removed and a small quantity of oil placed in the cylinders to lubricate the surfaces of the cylinder walls and pistons. The cooling system of the motor should be completely drained.

Back-Pack Pumps

Failure of back-pack pumps in service may usually be traced to one of the following causes: Abuse, clogged waterway, worn-out packing, weak spring on plunger check valve stem, or check-ball in hose end fitting corroded into seat. These can be minimized by careful handling, periodic inspection, and care in filling.

Avoid forcing the plunger. If it works hard for the full length of the stroke, it is an indication that the packing is too tight or the plunger is "gummed." Cleaning and applying a little light oil will generally correct the trouble.

Check for leaks, drain, and dry thoroughly before storing.

Rubber and Rubber-Lined Hose

Good hose will last a long time if it is given proper care and not abused. The principal sources of damage to all kinds of hose are mechanical injury, heat, mildew and mold, acid, gasoline and oils, and abrasions from dragging over the ground.

Care in rolling or folding the hose and in its use at fires can do much to avoid failures due to mechanical injury. However, hose can be injured mechanically even when it is not in use. When rubber-lined hose is hung over racks for a considerable period, both the cotton jacket and the rubber are under certain stresses which may cause permanent kinks or failure when pressure is applied. Frequent changing of the hose in hose beds and on reels and racks helps to avoid these strains. A satisfactory method of storing rubber-lined hose is to roll loosely and store horizontally. Store in a cool place, as in warm rooms the rubber lining will become hard and brittle.

Bacteria cause rapid deterioration of rubber-lined hose when it is not properly dried. These organisms break down the fibre of the cotton jacket, and are most active when hose is rolled while very wet and stored in a damp cellar, when it is stored for months on a damp dirt floor, or when wet hose is placed in a hose bed after use at fires and left for a long period.

Another very common cause of rubber-lined hose failure is damage by sulphuric acid. Minute amounts of this acid char and burn the cotton jacket to a powdery mass and at such acid-eaten spots the rubber lining will fail at relatively low water pressures. It is amazing how easily fire hose can come in contact with sulphuric acid. It may be dragged across a parking space where acid has dripped from a car battery, or it may be stored in a room with chemical extinguisher rechargers and dragged across the floor where it will pick up some acid. There is a certain amount of sulphur in rubber. When water is left in rubber-lined hose for a period of time, minute amounts of sulphuric acid form, and when a length of hose is moved, the acid, strong enough to eat the jacket, drips on it or some other length.

Many feet of fire hose have been ruined by gasoline and oils coming in contact with the rubber lining. Ordinary rubber is solvent in gasoline, and oils have a tendency to soften the rubber lining. It is very easy for oil and gasoline to come in contact with the rubber lining of hose, as the cotton jacket picks it up and acts as a wick carrying it to the rubber. The lining or the cement holding the lining and jacket together then dissolves and failure results.

Acids and oils also affect rubber hose, but damage is less serious because of the thickness of the rubber.

Linen Hose

Recent development in linen-hose weave and mildew-proof treatment permits the use of such hose under conditions which formerly were considered too severe for lightweight fabric hose. Improvement in the method of weave has produced a tight hose which seals rapidly, once saturated, and is no more rigid when wet than the loose, flexible weaves formerly available. Positive sterilization of the fabric is possible so that the loss from mildew is removed.

While mildew-proof treatment removes much of the danger of loss from deterioration, the same treatment in storage should be given linen hose as suggested for rubber-lined hose; storage in a cool, dry place after thorough cleaning and drying.

Washing and Drying—Rubber-Lined and

Hose should be thoroughly cleaned after testing or use on fires. Avoid the use of hard bristle brushes, which may injure the fabric. When hose has been exposed to oil, the oil may be removed by washing with soap or a mild alkali and rinsing properly. After cleaning, hose should be hung or placed on a rack to dry thoroughly. It should not be dried in the sun or on concrete roadways or sidewalks, because of the intense heat on such surfaces.

Hose Couplings

Hose without couplings or with couplings that are damaged is worthless at a fire.

Couplings should never be dropped or dragged on the ground unnecessarily, as this will result in bent or battered threads, or swivels so dented or sprung that they will not turn.

Couplings should be inspected every time hose is changed in the hose bed. Note threads on both male and female couplings; see whether swivels work freely and whether the gasket is of correct size and in its proper place.

FIRING EQUIPMENT

The use of flame throwing or firing equipment of necessity involves some hazard. Care in the assignment of such equipment and close adherence to the instructions for operation will contribute materially to long life and safe use.

Leaks are probably responsible for most of the failures, as well as most accidents. Torches and flame throwers should be inspected regularly for leaky valves and tanks, ruptured hose, and loose couplings and clamps. They should be carried so that it would be impossible for the hose to become damaged or valves to be turned on accidentally. Keep the tanks clean and wiped dry. Avoid overfilling.

Strainers on the Hauck torch and similar types should be cleaned after each use. When using the back-pack flame thrower, make certain that tank cap, pump packing, and attachments are all tight. Wipe tank clean after filling. The main risk in using this device is accidental spilling of oil on the clothing of the operator.

LIGHTING EQUIPMENT

Electric Flashlights and Headlights

Battery-equipped lights should be thoroughly checked and reconditioned if necessary after each fire. Remove batteries before storing. Shut off light whenever possible, as intermittent use will approximately double the battery life.

Carbide Lights

Clean thoroughly after each use. Check flint and steel for condition. Inspect gas jet; it may be clogged. Ordinary screen wire can be used to ream the jet of the standard miner's lamp. Keep carbide containers tightly covered and store in a dry place.

Pressure Lanterns

Lanterns of this type are used extensively in fire control activities and are probably among the most exasperating equipment items from the standpoint of safety and maintenance. This, however, can be attributed mostly to failure to observe precautions recognized as mandatory for satisfactory service. Observance of the following precautions and ordinary care in handling will eliminate to a considerable extent the difficulties usually experienced.

1. Fill bowl only three-fourths full to allow space for air.
2. Do not build up excessive pressure in bowl.
3. Generate and light outside of and away from any structure or inflammable material.
4. Turn on gas only after the lantern has started to generate.
5. Discard until repaired any lantern with leaky bowl, valves, or joints.
6. Fill lanterns outdoors, preferably using small filter funnel to avoid spilling gasoline and to prevent clogging of fuel line.
7. Never fill near an open flame. Do not attempt to refill when mantles are hot. Use flashlight for light when filling at night.
8. Wipe thoroughly after filling.
9. Never replace the filler plug with a cork or home-made plug.
10. Leave top of lantern and shade on when in use.
11. Place or hang sufficiently far from walls or ceiling to prevent fires.

CAMP EQUIPMENT

Blankets and Quilts

Immediately after each period of use on fires, blankets and quilts should be laundered, mothproofed, and stored to afford protection against rodents.

If sufficiently plentiful, they can be bundled prior to storage in convenient sizes to facilitate transporting to the field, or made up in bedrolls.

Sleeping Bags

Sleeping bags should be stored in a dry place and protected from vermin. All bags should be fumigated after use on fires, and sheets should be removed and laundered.

The pads in goosedown bags should be dry cleaned, never washed. If there are no removable sheets, the entire bag should be dry cleaned.

Mess Equipment

The following covers briefly satisfactory methods of cleaning, oiling, and storing the usual run of mess equipment.

Cleaning

Soot, fire blacking, and grease may be removed from tinware by soaking in hot water containing about one can of lye to each 5 gallons of water.

The utensils should be allowed to soak for some time in this solution, then removed, rinsed in clear water, and immediately washed in a third vat or tub of warm soapy water. The lye solution does nothing more than cut the grease, soot, and blacking, so that it may be washed off readily. This solution should be used only upon tinware. Aluminum ware should *never* be put in lye water.

When washing heavy pots, pans, griddles, and similar items which have become exceptionally coated, the solution may be strengthened to two cans of lye to 5 gallons of water, or even more. When using this strengthened solution, care should be exercised to see that it does not come in contact with the bare hands.

A solution of one teacupful of oxalic acid to 5 gallons of water may be used satisfactorily for aluminum ware. The utensils are allowed to soak in this bath, then washed in the manner previously described. There are also several types of cleaning wools and soap cakes on the market which are suitable for cleaning aluminum ware. Coarse steel wool, copper fiber, and other types of harsh abrasives should be used with care as they may scratch the aluminum ware excessively.

Where there is objection to the use of lye for tinware, or a separate solution for aluminum ware, commercial cleansers can be obtained which are not injurious to the hands and can be used with aluminum. While more expensive than the solutions suggested, these cleansers are preferred in some areas and can generally be obtained locally.

Oiling

All kinds of cooking and mess equipment, except, of course, aluminum ware and wooden articles, should be given a thin coat of mineral oil before being repacked or stored. Utensils to be coated should be fairly warm and the oil should be kept at a temperature which will permit easy handling. In applying the oil, use a soft cotton rag or cloth which has been saturated with oil and thoroughly wrung out. A thin coat is all that is necessary.

Dipping cooking utensils in hot oil is not satisfactory, because it leaves too much oil on them which necessitates washing them before using.

Storing

Cooking and mess equipment which has been thoroughly cleaned and dried, and properly oiled, can be nested and stored without danger of rusting. It is best to place oiled mess equipment in a thoroughly dry place, preferably of even temperature, although this is not absolutely necessary. Tinware and steel articles which have not been oiled must be stored in a thoroughly dry place, and it is desirable to keep them at a moderately warm, even temperature because variation in temperature or exceptionally cold temperature induces condensation and causes rust.

INDEX

All items described in this handbook are listed alphabetically in this index. A number in the "Spec. Number" column indicates that the master specification file contains a specification for the item. In the "Information Reference" column, the word "Mandatory" indicates that use of the specification is required, as outlined in the handbook foreword. Where an item is covered by an adequate Federal Specification, the number is given; thus, "Fed. W-B-101a." Numbers of Forest Service Regions, names of states, etc., in this column indicate sources of information or plans for certain items. Where the letter "P" is affixed to a regional number, purchases should be made through that region, as outlined in the foreword. The words "Hdbk. plan" indicate that a drawing of the article will be found at the end of the handbook section where it is described.

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TAHOE NATIONAL FOREST
Foresthill Ranger District
Foresthill, California
MAR 5 1948
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D.R.
F.C.A.
DISP.
OTHERS

January 13, 1948
Amendment List No. 1

HANDBOOK FOR FIRE CONTROL EQUIPMENT

FOREST OFFICER:

The following amended pages of the Handbook of Fire Control Equipment are transmitted herewith for insertion in your copy of the Handbook. Please destroy superseded pages.

	New Pages	*Superseded pages*
Contents	new page	old page
Forward	V to VIII	V to VIII
Section A	A-1 to A-8 (pages A-9 to A-12 are missing)	A-1 to A-12
	Plan for Fire Weather Instrument Shelter, R-1 type	new page
Section B	B-1 to B-3	B-1 to B-5
	Plan for Fire Finder Stand	new page
	Plan for Lookout Map Base Board (Koch)	new page
	Plan for Lookout Mapboard	new page
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Section I	I-1 to I-8	I-1 to I-8
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Section J	J-7 to J-8	J-7 to J-8
Section K	K-17 to K-18	K-17 to K-18
Section M	M-1 to M-4	M-1 to M-4
Section N	N-1 (page N-2 is missing)	N-1 and N-2
	N-5 to N-8	N-5 to N-8
	Plan for Combination Ration Box and Table Top	new page
Section O	O-1 to O-3	O-1 to O-4
Section P	P-1 to P-2	P-1 and P-2
Section S	S-1 to S-2 (Pages S-3 and S-4 are missing)	S-1 to S-4
	Plan for Kapok bag roller	new page
Index	Index 1 and 2	Index 1 to 7

The separate alphabetical index is to be discarded. All handbook items are being listed alphabetically in the revised index with specification numbers and other data as applicable. All handbooks have two index guide sheets. Handbook users can discard one of them if they wish.

WM. P. KRAMER, *Chief*
Division of Operation.

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